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Eastern Cape Breton Lobster (LFAs 27-30): Stock status and biological effects of the increase in minimum legal size

Homard de l'est du Cap-Breton (ZPHs 27-30): État du stock et effets biologiques de l'augmentation de la taille légale

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ABSTRACT

Overall the status of lobsters has improved since 1997 in Lobster Fishing Areas (LFAs) 27-30 (Eastern Cape Breton). In these LFAs a series of management measures were introduced from 1998-2002. The largest change was a stepped increase from 70 to 76 mm carapace length (CL) in the minimum legal size (MLS) in LFA 27. With the adopted management measures, Egg/Recruit (E/R) doubled in LFA 27 and increased by a lesser amount in LFAs 28-30 based on earlier runs of the E/R model. Landings in LFAs 27, 29 and 30 were higher in 2001 than in 1997 (the year before management changes were introduced). Although 2001 is the last year for which reliable total landings data are available, catch rates from index logs indicate total landings in LFAs 27-30 were higher in 2003 than 2001.

Coincident with the increase in MLS in LFA 27, there were improvements in indicators for egg-bearing females in the north of LFA 27 and for indicators of market-sized lobsters throughout LFA 27. These indicators are based on catch rates from three sources: voluntary fishing logs, recruitment traps set by the Fishermen and Scientists Research Society (FSRS), and at-sea samples of the commercial catch. The observed changes in indicators were consistent with the expected benefits from the size increase.

Stock improvements in LFAs 29 and 30 resulting from the management measures were not detectable by the indicators, likely because changes in these LFAs were not as significant as in LFA 27. In LFA 29 catch rates of several size groups increased substantially in 2003 and the indicators for prerecruits were very positive. The source of the increase is unclear with the data currently available. In LFA 30 there are signs of increased exploitation, but removals are still low relative to LFA 27. The lack of reliable indicators for LFA 28 clouds the picture of stock status. Ongoing studies in LFA 28 will address questions related to lobster habitat in Bras d'Or Lake.

RÉSUMÉ

L'état général des stocks de homard des zones de pêche du homard (ZPH) 27 à 30 (est du Cap-Breton) s'est amélioré depuis 1997 à la suite de l'introduction, entre 1998 et 2002, d'une gamme de mesures de gestion. La hausse marquée de la taille réglementaire minimale (TRM) pour la ZPH 27, qui est passée de 70 à 76 mm, était la plus musclée de celles-ci. Le nombre d'oeufs pondus par recrue a doublé dans la ZPH 27 et augmenté, quoique de façon moins spectaculaire, dans les ZPH 28 à 30, d'après des passages antérieurs du modèle de ponte. Les débarquements provenant des ZPH 27, 29 et 30 étaient plus élevés en 2001 qu'en 1997 (année précédant l'introduction des nouvelles mesures de gestion). Quoique 2001 soit la dernière année pour laquelle des données fiables sur le total des débarquements soient disponibles, les taux de capture calculés à partir des données des journaux de bord des pêcheurs repères indiquent que le total pour les ZPH 27 à 30 était plus élevé en 2003 qu'en 2001.

On a observé, en étroite concordance avec la hausse de la TRM pour la ZPH 27, des améliorations dans les indicateurs relatifs aux femelles grainées dans le secteur nord de cette zone, ainsi que dans les indicateurs relatifs au homard de taille marchande à l'échelle de celle-ci. Ces indicateurs reposent sur les taux de capture établis à partir de trois sources : les journaux de pêche remplis volontairement, la pêche aux casiers pratiquée par la Fishermen and Scientists Research Society (FSRS) en vue d'établir le recrutement et les échantillons des prises commerciales prélevés en mer. Les changements observés dans les indicateurs vont de pair avec les retombées attendues de l'augmentation de la taille réglementaire minimale.

Les indicateurs ne révélaient pas d'amélioration dans l'état des stocks des ZPH 29 et 30 à la suite de la mise en oeuvre des mesures de gestion probablement parce que les changements n'y étaient pas aussi marqués que dans la ZPH 27. Dans la ZPH 29, les taux de capture de plusieurs groupes de taille ont considérablement augmenté en 2003, tandis que les indicateurs pour les prérecrues étaient très encourageants. Les données disponibles ne permettent pas d'établir clairement la cause exacte de cette augmentation. Certains signes indiquent un accroissement du taux d'exploitation dans la ZPH 30, mais les ponctions y encore restent faibles par rapport à la ZPH 27. L'absence d'indicateurs fiables pour la ZPH 28 brouille la vue de l'état de ce stock. Les études en cours dans cette dernière permettront de répondre aux questions sur l'habitat du homard dans le lac Bras d'Or.

INTRODUCTION

The lobster fishery off the east coast of Cape Breton Island occurs in Lobster Fishing Areas (LFAs) 27 to 30 (Figs. 1, 2). Approximately 90% of landings are in LFA 27. These LFAs all experienced large increases in landings in the late 1980s and early 1990s. Historical landings in LFA 27 (comprised of Victoria and Cape Breton counties) reached 1775 mt in 1900 and then trended downward, fluctuating mainly in the range of 700-1200 mt between 1900 and the 1960s (Fig. 3). The lowest recorded landings (< 600 mt) were in the late 1960s and early 1970s.

Management of Canadian lobster fisheries is based primarily on effort controls (seasons, limited entry and trap limits), on minimum legal size (MLS), and protection of ovigerous females (Tables 1, 2). Following a declining trend in landings in the 1990's, a report by the Fisheries Resource Conservation Council (FRCC) (1995), and discussions with industry, the Minister of Fisheries and Oceans called on industry to adopt measures that would double eggs per recruit (E/R, the average eggs produced by a single female lobster over her lifetime). A set of conservation measures for the spring lobster fisheries in the Maritimes Region was announced in April 1998. These measures, and those that were eventually adopted, are shown in Table 3.

The increase in MLS within LFA 27 (from 70 mm to 76 mm carapace length or CL) was among the most significant changes adopted by the Atlantic LFAs. With this change, the doubling target within LFA 27 was met given reasonable assumptions of fishing mortality. This is the only LFA in Atlantic Canada judged to have met the target of doubling E/R (Anon, 2001). Previous estimates using the Idoine-Rago model (Tremblay and Eagles 1998 and unpublished) indicate that with a 6 mm increase in MLS, E/R would increase by approximately 130% in the northern 3/4 of LFA 27 given an annual removal rate of 67%. With the same 6 mm size increase in the southern portion of LFA 27, the model indicated an increase in E/R of approximately 86% given an annual removal rate of 45%. If fishery removals were higher, then LFA 27 would have experienced a relatively greater increase in E/R.

For LFAs 28-30, the doubling target was not met and would not have been even if the conservation measures announced in 1998 were adopted. This is because these areas were starting out with a relatively high E/R (Tremblay and Eagles 1998).

The E/R model provided a direction for management of lobster fisheries based on what is known about lobster biology and the exploitation of lobsters in the various parts of Atlantic Canada. As another approach for developing management targets, the Report of the Lobster Conservation Working Group (Anon, 2001) recommended the development of data-intensive indicators (for example prerecruit abundance from traps) to set management targets. Stock status indicators should reflect what both industry and science perceive as important.

This document has three objectives: (i) to evaluate stock status within LFAs 27-30; (ii) to evaluate the effects of the recent management changes and (iii) to table and analyze some stock indicators for these LFAs. The focal time period is 1997-

2003 (to overlap with the last document in 1998) but data from earlier years are included depending on data availability.

METHODS

Data Sources

For the lobster stocks off eastern Cape Breton, virtually all data for assessment are obtained from the fishery. These data were collected by Invertebrate Fisheries Division (IFD) staff and by contractors on behalf of IFD. In addition to samples from commercial traps, data were obtained from "recruitment traps" by the Fishermen and Scientists Research Society (FSRS).

Commercial Landings - Up until 1947, landings were recorded by county; from 1947 onwards landings were recorded by Statistical District, which are smaller units than LFAs (Williamson 1992). LFA 28 was not recorded separately from LFA 29 until the mid 1980s. Landings data were tabulated from sales slips collected by DFO until 1995; in 1996 mandatory self-reporting logs were initiated. All landings data from 1991-2002 were obtained from the DFO's ZIF (Zonal Interchange File) database. The degree to which all landings are captured by the self-reporting logs is not evaluated here. Checks for the 2001 season indicated that there were at least partial records for 94% of the licenses in LFA 27.

LFA 27 was further divided into 4 subareas (Figs. 1,2): Northern - Cape St. Lawrence to Ingonish; North-central - Wreck Cove to Pt. Aconi; Central - Alder Pt. to Glace Bay, and Southern - Port Morien to Gabarus. The subareas correspond to statistical districts (S.D.) 1, 4, 6 and 7, with the exception that Glace Bay (in S.D. 7) is included in the Central subarea (Fig. 1).

Index Fishermen Logs - Index fishermen voluntarily kept fishing logs of daily catch and effort (number of trap hauls per day). Selection of fishermen was not random and was based on their willingness to contribute their information. It is assumed that annual fluctuations in the catch rate of logbook keepers reflect the fishery as a whole. All catch rate and length composition data (see below) are maintained in a structured database described initially in Hunter and Tremblay (1992) and updated in more recent unpublished documents.

The number of participating fishermen varied with area and year. For 2003 the number of voluntary fishing logs was 26 in LFA 27 (4.8% of total licence number), 4 in LFA 30 (20% of total licence number), and 2 in LFA 29 (2.8% of total licence number). No logs were available from LFA 28.

Fishermen Science Logs for recruitment traps - A new source of catch rate data is the Fishermen and Scientists Research Society (FSRS) recruitment traps. For LFAs 27-30 this project has been underway since 1999. Participation rates (trap hauls per participant) in the project are shown in Table 4. Fishermen participants use standard traps and a standard gauge (Fig. 4) to assign each lobster captured to a size group. Size groups are listed below:

Size 1 (less than 51mm)
Size 2 (51mm – 60.9 mm)
Size 3 (61mm – 70.9 mm)
Size 4 (71mm – 75.9 mm)
    Size 4.1 (sublegal lobsters 71 mm – 75.9 mm)
    Size 4.0 (legal lobsters 71 mm – 75.9 mm)
Size 5 (76mm – 80.9 mm)
Size 6 (81mm – 90.9 mm)
    Size 6.1 (sublegal lobsters 81 – 90.9 mm)
    Size 6.0 (legal lobsters 81-90.9 mm)
Size 7 (91mm – 100.9 mm)
Size 8 (101mm and greater)

Size groups 4 and 6 were partitioned so that legal and sublegal lobsters could be distinguished. To do so, participants noted whether the lobsters were above or below the current MLS. In LFA 27 for example, size group 4.1 included sublegal lobsters from 71-72.9 mm CL when the legal size was 73 mm (1999 and 2000); size group 4.0 was for legal lobsters from 73-75.9 mm CL.

Participants also recorded the sex of the lobsters and the presence of eggs.

Port and at-sea samples of the commercial catch - Samples of the commercial catch at dockside were obtained throughout Eastern Cape Breton between 1997 and 2003 (Tables 5). For two index ports (Little River and Fourchu) we obtained multiple sea samples per year mainly in recent years but also in the early 1990s (Table 6). The length frequencies of males, females and ovigerous females (in at-sea samples) were used to develop several indicators (see next section). In all cases the carapace length was measured with vernier callipers to the nearest mm. Measurements were rounded down so that an animal with a measured CL of 70 mm could have measured from 70.0 to 70.9 mm CL.

Data processing and derivation of indicators

The Report of the Lobster Conservation Working Group (Anon, 2001) suggested categories for possible stock indicators. These have been modified slightly in the following table.

Category	Possible Indicator
Legal sizes	- Commercial catch rate
Prerecruits	- Pre-recruit catch rate
Spawners	- Ovigerous female catch rate
	- Percentage of egged females in traps
Exploitation	- No. of trap hauls
	- Fishery removals of new recruits
	- Fishing mortality (F) from LCA
	- F from change-in-ratio
Distribution	- Changes in distribution
	- Habitat occupancy
	- Distribution of egged females
Ecosystem	- Predator and prey (e.g. rock crab) indices
	- Environmental based – e.g. bottom temperature

There are no indices for distribution with the exception of the annual trawl survey for groundfish. The gear used on the survey is not designed for lobsters but does catch them in some areas (e.g. southwest Nova Scotia, slope of Scotian Shelf). The survey has not captured any lobsters off Cape Breton because it does not sample close enough to shore at depths where lobsters are found in summer.

There are no readily available indicators for lobster predators or prey.

Indicators of prerecruits, legal sizes and spawners based on catch rate – We consider catch rate as an index of abundance, but make no assumption about the form of the relationship between catch rate and abundance. The catch rate may be linearly related with abundance over some abundance ranges but is likely to become non-linear at some high abundance because of trap saturation. Here we use catch rate as an indicator for legal lobsters, prerecruits and spawners.

From voluntary fishing logs we developed an indicator for legal sizes. We estimated the average annual catch rate per log as total weight for the season divided by total no. of trap hauls for the season. Catch rates were then averaged across fishermen by year and area and confidence intervals estimated.

From the FSRS trap data we developed indicators for prerecuits, legal sizes and spawners. For a given size/sex category, catch rates were estimated as the total number of the category captured over the season/total number of trap hauls over the season. For prerecruit sizes we used the FSRS size groups, splitting the size category containing the MLS into sublegal and legal portions. For spawners (ovigerous females) we examined the 70-75.9 mm CL (71-75.9 mm CL in the FSRS traps) in particular since this is the size interval over which the MLS increase occurred, and in LFA 27 a substantial portion of lobsters can become ovigerous within this interval.

From the at-sea samples off Little River (North-central subarea of LFA 27) and Fourchu (LFA 30) we developed indicators for prerecuits, legal sizes and spawners. Because these data represent specific dates within the season (as opposed to the FSRS data, which capture each day in the fishing season), we needed to account for the within-season trends in catch rate (Fig. 5). Legal lobster catch rates typically decline over the season as a result of removals. This trend is strongest in the north and weakest in the southern portion of LFA 27 and in LFAs 29 and 30 (Tremblay and Eagles 1996). While legal lobsters decline, ovigerous female catch rates typically increase (Fig. 5). Sublegal lobsters usually show no trend (Fig. 5). To estimate annual catch rates for legal sizes and spawners from these data, simple linear regressions were estimated for each group and year. These were used to estimate the catch rate mid-season (day 30).

Prerecruit catch rates in commercial traps are reduced after the addition of escape vents or after an increase in the size of escape vents. Escape vents were instituted in LFAs 27-30 in 1992-1993 and were not modified up to the end of 2003.

Exploitation indicators - Here we consider exploitation indicators as those related to fishing pressure. Fishing effort is a measure of fishing pressure, and a direct measure of fishing effort is the total number of trap hauls for a given area and season. For this document fishing effort was estimated by dividing landings (tons) by catch rate from index fishermen logs (kg/trap haul).

Size-based indicators of exploitation - The size structure of the catch contains information on the exploitation rate if certain assumptions are met. These include (i) that the measured size structure is representative of the trap catch (ii) that recruitment is constant; (iii) that there is no emigration of lobsters from the area as they increase in size, (iv) that natural mortality is not size dependent and variable across years and (v) that the minimum legal size is constant. If the above assumptions are reasonably met, then as exploitation increases, the proportion of smaller sizes increases.

Length frequency samples within a year and port were aggregated to obtain a single length frequency distribution representative of the annual landed catch. This was accomplished by weighting the individual length frequency samples by the portion of the landings captured during the period represented by the sample. By this method if a higher proportion of the catch is obtained in weeks 1-3, then samples during this period receive proportionately more weight in the overall length frequency. Lobsters below the MLS and females with eggs captured in at-sea samples were omitted from the analysis.

Assuming the above mentioned assumptions are reasonably met, simple indicators of fishing mortality are the percentage of the catch in the first molt class above the MLS, and the mean size. More complex indicators estimate fishing mortality as an instantaneous measure (F) or as a finite annual removal rate or exploitation rate (μ).

As for the simple indicators, some of these will be affected by variation in recruitment.

Here we estimate F using length-based cohort analysis (LCA) as presented in the last assessment of lobsters in LFAs 27-30 (Tremblay and Eagles 1998). LCA estimates F from a combination of length frequency data and estimates of natural mortality and the length of time the average lobster spends within each length category (delta-t's). We converted the F estimates from LCA to finite rates using $\mu = e^{(-F)}$.

All inputs to LCA were the same as in 1998 with the exception of the representative annual length frequencies developed for the period 1997-2003. As in 1998, we use LCA only for female lobsters. For this method the first size category used in 1998 (Tremblay and Eagles) was 70-75 mm CL. To maintain the same delta-t's as in the 1998 document, we narrowed this first category as the MLS increased (71.5-75 mm CL in 1998, 73-75 mm CL in 1999 and 2000, 74.5-75 mm CL in 2002 and 2003). This allowed the remaining size categories (and therefore the delta-t's) to be the same as in 1998 (5 mm intervals from 75-120 mm CL and 10 mm intervals from 120-160 mm CL).

We also present exploitation rate estimates from a change-in-ratio (CIR) method (Claytor and Allard 2003). This method uses the within-season ratio of exploited size classes to unexploited size classes. A major advantage of CIR methods is that they are not sensitive to annual variation in recruitment. The Claytor and Allard method uses the FSRS trap catch rates and size classes. The estimates presented here are based on the most up-to-date FSRS data.

Claytor and Allard (2003) recognize two types of exploitation. The usual or strict method considers only the exploited population and is defined as $\mu = C/N$ where C is the catch in numbers by the fishery, and N is the number of lobsters in the exploitable population (i.e. the legally harvestable portion of the stock) at the start of the fishing season. When the size of the exploited population changes over several years because of an increase in MLS, it is difficult to compare traditional exploitation estimates across years. For this reason the *extended exploitation rate* was defined by Claytor and Allard (2003) as $\mu^* = C/(N + N^*)$ where N^* is the number of lobsters in some unexploited size class. This allows a consistent base population across years, regardless of changes in the regulations. The CIR method was used to estimate extended exploitation for size groups affected by the MLS changes. Strict exploitation rates were estimated for larger sizes not affected by MLS changes.

The list of indicators used in the current document, together with the data source and calculation is provided in Table 7.

RESULTS

Landings

From 1997 through until the end of 2001 reported total landings for LFAs 27-30 increased by 30%. The largest percentage increase was LFA 29, the smallest in LFA 30. Only in the small LFA 28 were reported landings lower in 2001 than in 1997 (Table 8). Reported landings for 2002 and 2003 are not finalized. The trend for 1997-2001 contrasts with the period of 1990-1997 when reported landings (LFAs 27-30 total) dropped by more than 60%.

Reported total landings for LFAs 27-30 in 2001 were below the means for the periods 1981-90 and 1990-2000, but were well above the means for the 1960s and 1970s and the 50 yr. mean (Table 8). LFAs 28-30 (total) remain below most decadal averages, as well as the long term mean.

Within LFA 27, reported landings for all subareas increased from 1997 through 2001, with the largest percentage increase occurring in the North-central subarea followed closely by the South subarea (Table 9). In 2001 the Northern subarea comprised the largest portion of the landings (about 31%), followed by the Central, Southern, and North-central areas. This contrasts with the early 1990s when the Northern subarea comprised about 16% of the landings in LFA 27.

Legal Size Indicators

Catch rate from index fishermen logs - The mean catch rate of legal lobsters from index fishermen logs is shown in Fig. 6 and Tables 10 and 11. In 2003 mean catch rates ranged from 0.22 kg/trap haul in LFA 29 to 0.47 kg/trap haul in LFA 27 North. Compared to 1997 and 2002, catch rate in 2003 was higher in all LFAs and subareas. The increase in catch rates was more substantial when only the market portion of the catch is considered (Fig. 7).

Within LFA 27, the catch rate increase over 1997 was highest in the North, followed by the South, Central and North-central subareas. The Northern and North-central subareas have had the highest catch rates in the last 5 years. Market catch rates more than doubled in the North and Central subareas from 1997 to 2003 (Fig. 7).

LFA 29 mean catch rate was markedly higher in 2003, but this was based on only 2 logs (Table 11). LFA 29 catch rates continue to be lower than LFA 27 and LFA 30.

Although index fishermen represent less 5% of the total licences, they are a good predictor of total landings for all fishermen for those years where total landings are

available (1992-2001). Regressions of total landings on index log catch rates explain 70-97% of the variation (Fig. 8).

Catch rate from FSRS traps - The catch rate of all legal sizes from the FSRS traps in number per trap haul or npth (Fig. 9) showed modest similarity with the log catch rates. In terms of spatial differences, both indicators show the highest catch rates in LFA 27 North (1.0 npth in 2003), and the lowest in LFA 29 (0.4 npth in 2003). Both data sets showed the North subarea higher from 2001-03 than 1999-00, and increased catch rates in LFA 29 in 2003 compared to 2002. Otherwise the FSRS trap catch rates did not agree closely with the logbook catch rates.

The FSRS traps provide the only indicator for the small LFA 28 although it is based on only two participants. Surprisingly, they indicate the catch rate of legal sizes in LFA 28 is higher than LFA 29 and 30, and all subareas of LFA 27 except the North. This may be related to fewer trap hauls and longer soak times in LFA 28.

Given the increase in the MLS in LFA 27, it is of interest to consider the catch rate of market size lobsters. The npth of market sized lobsters in FSRS traps increased in most of LFA 27, with catch rates in the North subarea 73% higher than in 1999 (Fig. 10). The exception was the North-central subarea. This subarea had the fewest FSRS traps available for the catch rate estimate (Table 4). Overall the increase in market catch rates in FSRS traps was not nearly as marked as in the voluntary logs (Fig. 7).

For LFA 29, the npth of legal lobsters declined slightly from 1999 until 2002 and then more than doubled in 2003 (Fig. 9). Catch rate increased in LFA 28, and was stable in LFA 30.

Catch rate from at-sea samples - The npth of legal sizes off Little River from at-sea samples (Fig. 11) shows a marked increase from 1997 to 2001, a decline in 2002 and an increase in 2003. This is almost identical to the trend in the log catch rate for the North-central subarea (Fig. 7). A steady increase in npth of market lobsters is also indicated from the at-sea samples, unlike the npth of markets in the FSRS traps (Fig. 11). Catch rates of all legal sizes and of market sizes were substantially higher in commercial traps (at-sea samples) compared to the FSRS traps.

The npth of legal lobsters in at-sea samples in LFA 30 (Fig. 12) declined steadily from 1999 to 2003, unlike the indicator from index fisherman logs (Fig. 6), or the indicator from FSRS traps (Fig. 9). The catch rates estimated from at-sea samples were not consistently higher than the FSRS catch rates.

Prerecruit Indicators

Catch rate from FSRS traps - In LFA 27 the npth of 51-60 mm CL lobsters showed no consistent trend with the exception of an increase in 2002 (North) or 2003 (other subareas) (Fig. 13). The npth of prerecruits 61-70 mm CL generally declined from

1999 to 2001 and then showed no trend or increased slightly from 2001 to 2003 (Fig. 14). The npth of prerecruits 71 mm CL to MLS increased from 1999 to 2003 (Fig. 15). This was expected because the width of this size class increased over the time period due to the increase in MLS (size class was 71-73 mm in 1999-2000, 71-74.5 mm in 2001 and 71-76 mm in 2002-2003).

In LFA 29 the npth of all prerecruits was higher in 2003 (Fig. 13-15). The npth of 51-60 lobsters increased in LFA 30 from 2000 to 2003. For LFA 28 there are only 3 years of data and the 3 prerecruit sizes had mixed trends.

Catch rate from at-sea samples – The npth of prerecruits 51-60 mm CL and prerecruits 61-70 mm CL in at-sea samples off Little River declined from 2000-2003, differing from the npth in FSRS traps (Fig. 16). Given that the at-sea sample npth of these sizes was usually substantially lower than that in the FSRS traps, that latter catch rates are likely more reliable. Considering the 70-MLS prerecruits, the at-sea sample catch rates were as high or higher than those in the FSRS traps. The increasing trend from 2000-2003 was nearly identical to that seen in the FSRS traps (Fig. 15).

The npth of prerecruits 61-70 mm from at-sea samples in LFA 30 was substantially lower than that in the FSRS traps (Fig. 17). The at-sea sample npth increased steadily over the 1999-2003 period, differing from the npth trend in FSRS traps. Considering the 70-MLS prerecruits, the at-sea sample catch rates were generally lower than those in the FSRS traps, and demonstrated no trend over the period 1999-2003.

Spawner Indicators

Catch rate from FSRS traps – Within LFA 27 the catch rate of ovigerous females 71-75 mm CL increased in the North subarea from 2001-2003 (Fig. 18). There was also a lesser increase in the South subarea after 1999. The other subareas of LFA 27 showed no consistent trends over the 1999-2003 time period. Considering the npth of ovigerous females 81-90 mm CL (Fig. 19) and of all ovigerous females (Fig. 20), this increased in the Northern subarea and trended downward in the North-central and Central subareas. In the South subarea the npth of females 81-90 mm CL trended up, while all ovigerous females had no clear trend. Overall catch rates were lower in the South subarea than in the other three subareas.

In LFAs 28-30 the catch rate of ovigerous females 71-75 mm CL increased (LFAs 28) or showed no consistent trend (LFAs 29 and 30) (Fig. 18). The catch rate of ovigerous females 81-90 mm CL (Fig. 19) and of all sizes of ovigerous females (Fig. 20) changed little (LFAs 28 and 29) or declined (LFA 30). Overall, catch rates of ovigerous females in LFA 28 (0.7 per trap haul in 2003) were the highest of any area, while catch rates in LFA 29 (< 0.1 per trap haul in 2003) were the lowest (Fig. 20).

Catch rate from at-sea samples – Fig. 21 is a boxplot of the percentage of females 70-75 mm that were ovigerous during the first 3 weeks of the season off Little River from 1993 to 2003. Using only the first 3 weeks avoids the problem with the increase in ovigerous females as the season progresses. The percentage of females that were ovigerous was elevated in 3 of the 4 years since 2000 (Fig. 21). In Fig. 22 these data are treated somewhat differently with estimates based on day 30 from a regression of catch rate on day in the season. In addition the size group is adjusted to 71-75 for better comparison with the FSRS catch rate data (which is also plotted in Fig. 22), and larger ovigerous females are included. The plot for ovigerous females 71-75 mm CL agrees closely with Fig. 21. The estimated npth of ovigerous females 81-90 mm CL and of all sizes also increased from 1999-2003 and was higher than 1993-1997. Comparisons of the estimated npth in at-sea samples with the estimates from FSRS traps indicated the FSRS traps captured more smaller ovigerous females and more ovigerous females overall.

The estimated npth of ovigerous females (all sizes and 81-90 mm CL) from at-sea samples in LFA 30 declined from 1999-2003 (Fig. 23). There was no consistent difference in the relative catch rates of ovigerous females in commercial traps compared to FSRS traps. The catch rate of ovigerous females 81-82 mm CL and of all females > 135 mm CL was very low, and we provide estimates only for the years 1999-2001 when at-sea sampling in LFA 30 was most intense (Fig. 23). Estimated catch rate of ovigerous females 81-82 mm CL declined from a high in 1999, and the large females > 135 mm CL showed no trend.

Exploitation Indicators

Total Effort - The estimated number of trap hauls per year trended downward between 1997 and 2000 in most of LFA 27 (Fig. 24). In 2001 effort increased throughout LFA 27. Total estimated effort for LFA 27 in 2001 was 98% of the average of 1992-1995.

In LFA 29, estimated effort increased from 1997 to 1999 and then fluctuated. In LFA 30 estimated effort decreased in 1998 and increased slightly in 2001. Estimated effort for LFA 29 in 2001 was 97% of the average of 1992-1995; for LFA 30 the figure was 106%.

Size composition - Examples of size frequencies generated from port and sea samples of the commercial trap catch in 2003 are shown in Figs. 25 and 26. They illustrate that lobsters in commercial traps are on average larger in the South and in LFAs 29-30 than in the North, North-central and Central subareas of LFA 27. The size frequency distributions of lobsters in these 3 subareas of LFA 27 were quite similar in 2003. From the at-sea samples it is apparent that berried females are on average larger off Fourchu than Little River.

The percentage of lobsters in the first molt group (MG1) above legal size (size groups adjusted each year for increased MLS) shows some subarea and LFA differences (Fig. 27). LFA 27 North had the highest MG1 (75-83%) throughout the 1997-2003 period. LFA 27 Central and North-central were close behind. LFA 27 South had the lowest MG1 (34-52%), while LFA 29 and 30 were intermediate. While the estimated MG1 was up modestly in several subareas in 2003 compared to 1997, only in LFA 30 was there a substantial change from 1997-2003 (42% to 68%, with most of this occurring in 2003).

Spatial differences in mean sizes of lobsters (Fig. 28) show some of the same features as MG1. For the period 1997-2003 LFA 27 North had the smallest lobsters on average (77-83 mm CL), followed closely by LFA 27 North-central and Central. LFA 27 South (84-91 mm CL) was intermediate to LFAs 29 and 30 (94-101 mm CL). The latter 2 LFAs had very similar mean sizes.

The mean size of lobster increased throughout LFA 27 beginning in 1998 with the first increase in minimum legal size (Fig. 28). Mean size in LFAs 29 and LFA 30 trended downward over the same period even though the MLS increased by 3 mm in LFA 29 and 1.5 mm CL in LFA 30.

Length-based Composition Analysis (LCA) – LCA requires input of the size data in 5-10 mm intervals. An example of the input data (Littler River females) is provided in Fig. 29. This figure also serves to illustrate the shift in size to the right by 6 mm (the MLS increase) from 1998 to 2003.

Exploitation rate estimates from LCA for the LFA 27 subareas, and for LFAs 29 and 30 are provided in Fig. 30. For LFA 27, exploitation rate estimates continue to be highest in the North subarea (0.51 in 2003) and lowest in the South subarea (0.19 in 2003). Exploitation trended downward in each subarea. At least part of this reduction is a reflection of the narrowing of the width of the first size group (70-75 mm CL) due to the increased MLS. This had the effect of reducing the numbers harvested in the 70-75 mm CL interval.

For LFAs 29 and 30, exploitation rate estimates using LCA continue to be low. In 2003 the estimates were 0.24 for LFA 29 and 0.29 for LFA 30. For LFA 29 the estimate is close to that for 1997, while for LFA 30 the exploitation estimate has increased since 1997.

Change-in-Ratio (CIR) method (CIR) - CIR has the advantage of providing estimates for different sizes and for males and females. It also provides confidence intervals. To provide reasonable estimates it needs a substantial n (number of lobsters caught). For LFA 27, there is a sufficient number to provide a reliable estimate when all participants north of G'ace Bay are used (Fig. 31).

Extended exploitation rate (μ^*) estimates from CIR for the above area for the 1999-2003 period ranged from 0.42-0.61 for males 71-75 mm CL and 0.38-0.59 for

females 71-75 mm CL. For males 76-80 and 81-90 mm CL the strict estimates of exploitation (μ) ranged from 0.70-0.86 (~0.77 for both in 2003). For females in these size groups the estimates were 0.69-0.88 (~0.78 in 2003). As expected the extended exploitation rates of the smallest size interval declined to 0 reflecting the MLS increase. Strict exploitation rates estimates for larger sizes showed no trend as the MLS increased.

For LFA 27 South the number of lobsters captured in the FSRS traps did not allow CIR estimates of exploitation rate as precise as those for the other 3 subareas combined (Fig. 32). For males 76-80 and 81-90 mm CL, estimates of exploitation rate ranged from 0.61-0.90 (0.64 and 0.86 in 2003). For females in these size groups the estimates were 0.66-0.95 (0.66 and 0.79 in 2003).

Summary Table of Indicators

Table 12 summarizes the trends in different groups of indicators. In many cases trends over the specified period are not strong, but the Table is an attempt to summarize the direction of the indicators. This Table is discussed in more detail below.

DISCUSSION

Stock status within LFAs 27-30

Overall the status of lobsters within LFAs 27-30 has improved from 1997. The indicators are most positive for LFA 27 North but indicators of prerecruits in LFA 29, and to some extent LFA 30 are encouraging. There are some negative signs for LFA 30 (apparent decrease in ovigerous females, possible increased exploitation), but these are not a major concern.

Below we discuss and interpret the trends in the various groups of indicators.

Legal sizes - Landings increased in all areas from 1997-2001 reversing an earlier trend. While landings in 2001 were below the 10 year mean, they were above the 50 year mean in all LFAs (Table 12). It is unfortunate that these basic data are not fully available for more recent years. Improvements to the system of obtaining landings data are required.

Catch rates in 2003 from volunteer fishing logs were higher in most LFAs. Given the strong relationship between voluntary log catch rates and total landings for the period 1992-2001 (Fig. 8), landings in 2003 were likely higher than 2001. We consider the voluntary log book catch rates to be the best available indicator for legal sizes at this time.

Considering the period since management measures began to be introduced (1998) catch rates are either up substantially, or show a slight increase (Table 12). In LFA 27 North, catch rates are slightly higher than the early 1990's; for LFA 27 Central and South catch rates are as high as 1995-96. Only in LFA 27 North-central have

log catch rates been variable with no upward trend since 1998. Catch rates of market sizes were up through out LFA 27.

Catch rates of legal sizes in the FSRS traps showed an upward trend from 1999 to 2003 for LFA 27 North, but not the other subareas (Table 12). Market catch rates in FSRS traps were up in 3 of the 4 subareas of LFA 27.

Estimated catch rates of legal sizes from the at-sea samples in LFA 27 North-central were higher than the FSRS trap catch rates in the area. This is likely because the traps having escape vents, allowing sublegal lobsters to escape and enhancing the catch of legal lobsters (Krouse, 1989). In addition the at-sea samples represent greater spatial coverage. Any given at-sea sample consisted of approximately 250 trap hauls, whereas the FSRS daily catch rates were estimated from 10-15 trap hauls. Given the above factors plus the fact that there were relatively few FSRS participants in the North-central subarea (at least those that participated consistently), we consider the at-sea samples to be the better indicator of the npth of legal sizes for the North-central area.

Prerecruits – Prerecruit indicators are giving somewhat mixed signals. For some areas all prerecruit sizes (LFA 29) or some prerecruit sizes (LFA 30) are trending upwards. For other areas prerecruits are down from 1999 but otherwise variable.

One hypothesis to explain the decline in prerecruits 61-70 mm CL in LFA 27 is that with the increased MLS, more prerecruits 71-MLS were entering the traps and inhibiting smaller lobsters from entering. This does not appear to be the case. Although the npth of lobsters from 71-MLS in FSRS traps increased by a factor of 2 in some parts of LFA 27, the increase was not coincident with the decrease in npth of lobsters 61-70 mm CL. Most of this occurred between 1999 and 2000 (Fig. 14), when the npth of lobsters 71-MLS also decreased (Fig. 15).

In LFA 29, the strong increase in npth of all prerecruits in 2003 is encouraging but also a little puzzling. Although there was an increase in legal sizes (shown in log catch rates as well as FSRS npth data) in 2003, there was no increase in the immediate prerecuits (71 to MLS) in 2002. Either the FSRS traps did not register the increase in 2002, or legal lobsters were some how more available in 2003. There was an increase in the npth of prerecruits 51-60 mm CL in 2002 that was also apparent in LFA 30. Additional monitoring will help confirm whether recruitment in LFA 29 is truly on the rise, or whether lobsters of all sizes were for some reason more available in 2003 than in previous years.

FSRS prerecruit catch rates were usually markedly higher than those measured in at-sea samples from commercial traps. It is expected that increased participation in the FSRS recruitment trap program will result in better spatial coverage and increased reliability of the FSRS prerecruit indicators.

The relatively high catch rates of prerecruits 71 mm –MLS in commercial traps in LFA 27 indicates it is now time to consider regulations increasing the escape vent sizes.

Spawners - The upward trend in ovigerous female indicators in parts of LFA 27 is a positive sign. This trend was most evident in the LFA 27 North and to a lesser extent

in LFA 27 South (Table 12). In the North-central subarea an increase in ovigerous females was apparent only after examining the longer trend from at-sea samples. When the 2000-2003 period is compared to 1993-1997, ovigerous female catch rates from at-sea samples were higher. There was no evidence of an increase in ovigerous females in the North-central subarea from 2000-2003.

Within LFA 27, catch rates of ovigerous females were highest in the North and North-central areas. This is likely due both to higher concentrations of lobsters and to a smaller size of maturity in the North compared to the South. Estimates for the 50% size at maturity are 72-73 mm CL at Ingonish and Glace Bay, and 77-78 mm CL at Gabarus-Fourchu (combined) (Watson and Miller, unpublished).

Among LFAs, LFA 28 had the highest catch rate of ovigerous females. Although this bears closer study to determine any effect of longer soak times, other studies indicate LFA 28 has a high proportion of females with eggs (Tremblay, 2002).

The apparent decline in ovigerous females in LFA 30 raises some concern but needs to be considered in relation to adjacent areas and what is known about the size at maturity in the area. FSRS catch rates of ovigerous females in LFA 30 in 2003 were similar to the adjacent LFA 27 South. LFA 30 is one of the few management units that have an MLS (82.5 mm CL) that is larger than the estimated 50% size at maturity (78 mm CL). Lastly the apparent decline needs confirmation with additional sampling. This area shows annual variability in the timing of the late season increase in ovigerous female availability, possibly related to annual variability weather and bottom temperatures (Tremblay, unpublished data). Variation in the timing of at-sea samples would also contribute to variability in the indicator based on these samples.

While the spawner indicators in LFA 27 are positive overall, and indicate increases in egg production, there is no guarantee of increased recruitment in future years. Egg, larval and juvenile survival must be as high as the previous years in order for the increased egg production to result in increased recruitment to the fishery. It will take considerable monitoring to determine if increased recruitment occurs. We likely need more FSRS trap hauls to increase the chance of detecting increased recruitment because of the inevitable sampling variability. Variability in the prerecruit indicators can be expected due to weather, bottom temperature, trap placement, and a host of other factors.

When would we expect to be able to detect increased recruitment from the MLS increase? Given that the FSRS traps can provide reliable indicators of lobsters 51-60 mm CL, we need to know the length of time it takes a lobster to reach these sizes. Our best estimate is that most lobsters would reach a size of greater than 50 mm in 4 years after hatching. Hudon (1987) presented data indicating that lobsters could reach 50 mm CL in 2 molting seasons after hatching; these would show up in a spring fishery about 2 years and 10 months after hatching. Lobsters would need another molting season to grow above 50 mm CL, and then could potentially enter FSRS traps the following spring fishing season. This is basically 4 years. In 2003, we expect that lobster eggs were hatched from females protected by the new MLS of

76 mm CL (in place in 2002). The bulk of the lobsters hatched in 2003 would be expected to show up in FSRS traps as 51-60 mm CL lobsters in the spring of 2007.

Exploitation - Our direct measure of effort (number of trap hauls) indicates that effort increased in 2001, but was still below the average for the 1990s. Effort in LFAs 29 and 30 was up modestly compared to 1997 (a low year for LFA 30) but is still within the range of estimates for the 1990s. Whether effort increased or decreased after 2001 is not known because landings for 2002 and 2003 are not finalized.

The direct estimate of effort is dependent on both good landings data and good catch rate data. Improvements in both are needed. While the correlation between landings and log catch rates for the period of 1992-2001 is encouraging, the logs still represents a small proportion of the total fishermen. In addition the landings data need to be more up to date. Lastly, our direct estimate of effort does not pick up increases in the quality of effort due to vessel and navigation improvements.

Spatial differences in size structure indicative of exploitation rates have not changed substantially since the last assessment. Within LFA 27, the North subarea still catches the smallest lobsters, and the South subarea still catches the largest lobsters. LFAs 29 and 30 continue to have the largest lobsters but the gap between these LFAs and LFA 27 has narrowed due to the MLS increase. Within LFA 27 the increased mean sizes show that the MLS increase had the desired effect. In LFAs 29 and 30 there was a decrease in mean size in spite of the MLS increases. This decrease is likely due to increased recruitment rather than increased exploitation (particularly in LFA 29).

The percentage of lobsters in molt group I increased modestly in parts of LFA 27 between 1997 and 2003. The increase was more substantial in LFAs 30 and 29. As for the reduction in mean size in LFAs 30 and 29, this increase may be partially due to increased recruitment.

The CIR estimates show the extended estimates of exploitation (μ^*) for the smallest size group diminishing as expected given the MLS increase. It is of interest that the estimates of strict exploitation rate (μ) for larger sizes did not increase over the period, indicating that the MLS increase did not result in increased pressure on these sizes. A comparison of current estimates of exploitation with those in previous years is displayed in the following text table.

Estimation method/year(s)	LFA 27 N	LFA 27N-c	LFA 27C	LFA 27 S	LFA 30	LFA 29
Petersen 1994-95	0.55	0.54-0.65		0.41		
Leslie 1996	0.70	0.72	0.75	0.47		
LCA 1993-97		0.49-0.58		0.21-0.25	0.31-0.27	0.20-0.25
LCA 1997	0.58	0.51	0.56	0.23	0.21	0.22
LCA 1998-03	0.57-0.51	0.51-0.35	0.50-0.40	0.31-0.15	0.21-0.29	0.15-0.24
LCA 2003	0.51	0.43	0.45	0.19	0.29	0.24
CIR 1999-03 (M & F 76-90 mm)		0.68-0.88		0.40-.95		

The different methods for estimating exploitation are biased in different ways. Tremblay and Eagles (1998) noted that the LCA method resulted in lower estimates than other methods. We consider the Petersen estimates from our 1993-94 tagging study (Tremblay and Eagles 1996, Tremblay et al. 1998) to be most reliable. These are based on returns of tagged animals and should if anything be underestimates because not all tags are returned and there is some tag loss. Estimates for the North-central subarea from Petersen ranged from 0.54-0.65. LCA estimates for 1994-95 for this subarea were 0.49-0.53. Recall that we are using LCA only for females, and that it considers all size ranges. The method may be biased low because it incorporates estimates of molt frequency that are not well modelled for larger sizes.

The CIR estimates are limited by samples sizes but the fact that they are not sensitive to annual variations in recruitment and have confidence limits increases their value. Comeau and Mallet (2001) compared exploitation estimates generated from a mark-recapture method, a catch-effort method and a CIR method. The CIR estimates were the highest, but were judged to be more accurate than the lower estimates generated from mark-recapture.

While the true exploitation rates are likely higher than those estimated by LCA, for the purposes of this document we concern ourselves with the trends rather than the absolute value of the estimates. The LCA method is the only one available for every year because they require only length frequency data. This method indicates a downward trend in exploitation rate for LFA 27 from 1997-2003. Some of this is likely due to the dropping out of a size group (70-75.9 mm CL). The LCA estimates of exploitation increased for LFAs 29 and 30. For LFA 29 at least, this increase may be artificial and due to increased recruitment, as indicated by increased catch rates of prerecruit sizes (Fig. 14).

To summarize stock status in LFA 27, there are positive and encouraging signs. These are increases in the catch rates of legal sizes, increases in indicators for spawners, reduced extended exploitation, and the fact that the size composition changed in a manner consistent with expectations from the MLS increase. Prerecruit indicators are more mixed, but do not suggest imminent declines.

In LFA 29 there are positive signs of increased recruitment that need to be verified with continued (and hopefully increased) monitoring with FSRS traps. In LFA 30 there are signs of increased exploitation, but exploitation is still low relative to most of LFA 27. This LFA also shows signs of decreased ovigerous females, but these are not a major concern as yet. LFA 30 would also benefit from an increase in monitoring with FSRS traps.

With regard to the status of LFA 28 (Bras d'Or Lake), this is the only LFA where landings in 2001 were lower than 1997. Whether this represents a downturn is not clear as there could be errors in landings data for this small LFA. FSRS catch rates of legal sizes for this LFA were stable from 2001-2003. Unfortunately there are few longer-term data available. The overall status of lobsters in LFA 28 is the subject of an ongoing joint study conducted by Eskasoni Fish and Wildlife and Invertebrate Fisheries Division, B.I.O. The study has two parts: i) trapping within and outside of the season to examine seasonal and spatial patterns and (ii) examination of lobster densities in relation to bottom habitat using underwater video and diver estimates of density. A report on this work will be available in 2004. These studies will improve our understanding of what limits lobster production in Bras d'Or Lake.

Effects of recent management changes

The effects of the size increase in LFA 27 are clear and most evident in the North subarea as expected. LFA 27 North had the highest proportion of lobsters between 70 and 76 mm CL prior to the MLS increase. Therefore when the size was increased this was the subarea where the highest proportion of lobsters was left in the water to grow and reproduce. Below are some of the positive changes that are consistent with the expected effects of the size increase:

- Increase in the catch rate (weight per trap haul) of all sizes of legal lobster in LFA 27 North and most of the remainder of LFA 27 (index fishermen logs)
- Substantial increase in the catch rate (no. per trap haul) of market sized lobsters in all of LFA 27 (index logs and FSRS traps)
- Increase in the catch rate (no. per trap haul) of ovigerous female lobsters between 71 and 75.9 mm CL in LFA 27 North from 1999-2003 (FSRS traps) and in LFA 27 North-central (2000-2003 compared to 1993-1997)
- Decrease in extended exploitation rates in LFA 27 with no accompanying increase in strict exploitation of larger sizes

The increase in catch rate of legal lobsters in parts of LFA 27 is almost certainly due to increased yield per recruit resulting from the increase in MLS. Lobsters previously captured at a size of say 73 mm weighed 317 g (0.7 lb). When allowed to molt

before capture, these lobsters were caught at a size of approximately 84 mm CL and a weight of 480 g (1.1 lb).

Similarly, the increase in ovigerous female catch rates and in percentage of ovigerous females in the size range of 70-75.9 mm CL is likely a direct result of the size increase. Prior to the MLS increase, many of the ovigerous lobsters in this size range would be captured prior to egg extrusion.

The direct effects of management measures in LFAs 28, 29 and 30 were not detected. Catch rate of legal sizes in LFAs 29 and 30 was higher in 2003 than 1997 (Table 12). Part of this might be attributable to the size increase and the resultant increase in yield (Table 3) but with the small MLS increase in LFA 30 such a yield increase is likely too small to be detected. In LFA 29 and 30 we did not detect increases in ovigerous females in the newly protected size classes, or increased weight in larger sizes (due to increased yield-per-recruit). Nor did we detect an increase in the catch rate of females larger than 135 mm CL in LFA 30.

The effects of the management changes on the lobster stocks in LFAs 28-30 are more difficult to detect for a variety of reasons. First, the changes were not as substantial as in LFA 27 (3 mm and 1.5 mm increases in CL compared to 6 mm increase in LFA 27). Second the percentage of animals in the first molt group was never as high as in LFA 27. Third, sampling of these areas has been less effective because catch rates are generally lower. We did conduct extensive sampling in LFA 30 from 1999-2001 but resources limited us from continuing this in 2002-03. FSRS participants have provided excellent data for these LFAs. To be able to detect smaller changes in stock status, more participants will be needed. If there were sufficient participants, reliable CIR estimates of exploitation would be possible.

In LFA 29 a maximum ring size (153 mm or approx. 6") was put into effect in 2000. With the help of fishermen in LFA 30 an extensive study was conducted to assess the effect of different ring sizes on the catch rate of lobsters of different sizes (Appendix I). Overall catch rate of legal lobsters was highest in traps with 5.75" and 5.25 "entrance rings, followed by traps with 6.85" ring traps and 7.35" ring traps. The traps with rings larger than 6" captured more lobsters > 150 mm CL. The numbers of these sizes was low overall (approx 1.2 lobsters /200 trap hauls in both 2000 and 2001). This study indicates that a maximum hoop size has some effect on reducing the catch of large lobsters.

Are there further management changes needed? First and foremost, it is time to consider increasing the size of escape vents in LFA 27 traps to reduce the catch rate of prerecruits. At present prerecruits 71-75.9 mm CL are captured in commercial traps at the same rate as the FSRS traps. Second, there should be effective measures to protect large female lobsters. There is some protection in LFA 30 and somewhat lower protection in LFA 29, but none elsewhere. While it cannot be demonstrated that the spawning of large females is important to the future health of lobster stocks, it is prudent to promote the protection of a wide size range of spawners.

Recommended stock indicators for LFAs 27-30

We have considered a range of indicators in the current document. For prerecruits, those based on the FSRS traps represent a short time series but they likely provide the best indicators since the traps are designed for this purpose. FSRS traps typically had higher catch rates of prerecruits than commercial traps. The indicators will become more reliable with increases in the number of participants.

For legal sizes, fishermen logs of catch and effort are vital. The index logs were strongly correlated with landings (1992-2001) and appear to provide the best available indicator of landings for 2002 and 2003. It is recommended that more data on catch and effort be collected to increase the degree to which these data represent the fishery as a whole. This would happen with the addition of effort data to mandatory logs. During the transition to such a system, it is important to continue with the index log program.

The FSRS data also provided indicators for legal lobsters that were correlated with other sources. For example the catch rates of markets increased in most of LFA 27 in the FSRS traps, as did the catch rate of ovigerous females in the North subarea. FSRS traps picked up an increased catch rate of legal lobsters in LFA 27 North and in LFA 29.

For spawner indicators, there was some disagreement between those based on FSRS traps and those based on at-sea samples. Some of this was due to differing periods of observation. In LFA 27 North-central, at-sea samples were available from 1993-1997 for comparison with more recent years. FSRS data were available only from 1999 onwards. In addition LFA 27 North-central had relatively few participants in the FSRS program. There were several dedicated participants, but more are needed. The FSRS traps often had higher catch rates of ovigerous females, suggesting they were in more favourable locations. Two recommendations are made: (i) conduct a study comparing commercial catch rates of spawners with commercial traps; (ii) increase the number of participants so that each subarea has at least 10 consistent participants. This probably means having 12-15 in any given year to account for participants dropping out.

Exploitation indicators come from several sources: logs, landings, length frequencies from samples of the commercial catch and FSRS traps. Dockside samples of the commercial catch provide data on the size composition of the catch. These data have been used for simple estimates of exploitation and the more sophisticated LCA. These length-based indicators have caveats and must be interpreted with caution. These indicators will be strongly affected by other factors such as recruitment and in the case of mean CL, regulation changes. If we are to continue to use these size-based indicators, it may be possible to reduce the frequency of the port samples since the length composition does not change substantially from year to year. The change-in-ratio indicator of exploitation appears promising since it does not depend on length data.

At present we have no direct data on the spatial distribution of landings and effort. This is needed to monitor possible changes in distribution of lobsters and fishing effort. Such data will be valuable not only for developing a suite of indictors based on distribution, but to map overlap of fishing gear with proposed industrial development, and with the distribution of species at risk.

Lastly a program of out-of-season monitoring of the abundance of lobsters in portions of LFAs 27-30 should be considered. It would take considerable effort to develop such a program, but it could provide valuable data on distribution and abundance during the large portion of the year (10 months) outside of the commercial fishery.

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Table 1. License numbers by Lobster Fishing Area in 2003. Obtained from Maritimes Region DFO Licensing, and Gulf Region DFO Licensing ("A" license total includes 44 from the port Bay St. Lawrence, which is in LFA 27, but part of the Gulf Region).

	A	B	Partnership	Total Licenses
LFA 27	490	29	12*	543
LFA 28	15	2	0	17
LFA 29	59	12	1*	73
LFA 30	20	0	0	20

* each counted as 2 licenses because a partnership license can revert to 2 separate licenses.

Table 2. Seasons, trap limits, and minimum legal sizes by LFA as of 2003. From Schedule XIV of the Atlantic Fishery Regulations.

Area	Season	Trap limit	Minimum legal size (mm)
LFA 27	May 15 - Jul 15	275	76
LFA 28	May 9 - Jul 9	250	84
LFA 29	May 10 - Jul 10	250	84
LFA 30	May 19 - Jul 20	250	82.5

Table 3. Lobster conservation measures announced by the Minister of Fisheries and Oceans in 1998 for LFAs 27-30 along with those in place by 2002. MLS = minimum legal size. Note that the escape mechanisms were not modified from 1998-2003. CL = Carapace length.

Area	Announced	In place by 2002
LFA 27	• Increase MLS from 70 mm to 75 mm CL • Maximum size of 127 mm CL for females	• MLS increased to 76 mm CL
LFAs 28 & 29	• Increase MLS from 81 mm to 86 mm CL • Maximum size of 127 mm CL for females	• MLS increased to 84 mm CL • Maximum hoop size of 153 mm
LFA 30	• Increase MLS from 81 mm to 86 mm CL • Maximum size of 127 mm CL for females	• MLS increased to 82.5 mm CL • Maximum size of 135 mm CL for females

Table 4. Participation in FSRS recruitment trap project 1999-2003. Shown is number of trap hauls for each fisherman (code is arbitrary). All fishermen maintained 5 standard traps. Grayed out cells were not used in catch rate calculations.

Subarea	Code	1999	2000	2001	2002	2003
27 - North	1	129	132	129	132	123
27 - North	2	114	132	118	123	129
27 - North	3	135	135	145	143	128
27 - North	4	132	138	135	94	132
27 - North	5	173	184	173	162	154
27 - North	6		123	126	131	129
27 - North	7					132
27 - North	8					126
27 - North	9				5	129
27 - North	10					76
27 - North-central	11	240	220	230	225	210
27 - North-central	12	195	195	195	195	220
27 - North-central	13	152		185		120
27 - North-central	14	156	138	117	117	
27 - North-central	15	116				
27 - North-central	16		54	69	120	
27 - North-central	17					122
27 - Central	18	220	171	140	128	123
27 - Central	19	138	126	114	93	126
27 - Central	20	138	123	129	108	120
27 - Central	21	138	129	138	132	126
27 - Central	22	210	230	225	155	209
27 - Central	23	210	165	186	195	225
27 - Central	24	228	250	240	255	260
27 - Central	25		190	205	150	179
27 - South	26	295	250	265	255	215
27 - South	27	190	110			
27 - South	28	135	117	105	78	84
27 - South	29	149	144	135	141	137
27 - South	30		114	132	144	
27 - South	31			172	170	178
27 - South	32					132
27 - South	33					180
28	34			145	159	140
28	35			81	185	124
29	36		75	135	120	40
29	37		135	202	205	230
29	38		190	225	215	215
29	39		195	190	185	180
30	40		84	110	165	140
30	41		235	243	220	235

Table 5. No of port samples 1997-present

LFA	SDATE	1997	1998	1999	2000	2001	2002	2003
27	DINGWALL	3	3	2	2	2	2	2
27	NEIL'S HARBOUR	2	2	2	3	3	2	2
27	LITTLE RIVER	3	3	11	2	3	2	2
27	ALDER POINT	4	2	2	2	3	0	0
27	GLACE BAY	3	3	2	4	2	0	0
27	NORTH SYDNEY	3	2	2	3	2	2	2
27	LOUISBOURG	4	3	2	3	3	2	2
27	MAIN-A-DIEU	4	2	2	1	2	0	0
30	FOURCHU	1	8	0	0	0	0	0
29	L'ARDOISE	2	4	1	2	3	1	2
29	ISLE MADAME	0	21	1	16	3	2	
29	PETIT DE GRAT	0	8	2	0	0	0	2

Table 6. No of at-sea samples at index ports.

	No. samples	
Year	Fourchu	Little River
1990	4	0
1991	4	0
1993	0	4
1994	0	22
1995	0	2
1997	1	2
1999	7	9
2000	21	12
2001	20	8
2002	2	9
2003	2	7

Table 7. Stock indicators used in the present document.

Category	Indicator	Data Source	Calculation
Legal sizes	1. Total Landings	- DFO statistics	
	2. Weight per trap haul	- Vol. Index logs	- Tot Weight landed/ Tot N Trap Hauls
	3. No. legal lobsters/trap haul	- FSRS traps	- Tot No. counted/Tot N Trap Hauls
	4. No. market lobsters/trap haul	- At-sea samples	- Estimated catch rate on day 30 from regression of at-sea sample Npth on day in season
Prerecruits	1. No 51-60 mm lobster/trap haul	-FSRS traps	- Tot No. counted/Tot N Trap Hauls
	2. No. 61-70 mm lobsters/trap haul		
	3. No. 71 mm-MLS lobsters/trap haul	-At-sea samples[1]	- Estimated catch rate on day 30 from regression of at-sea sample Npth on day in season
Spawners	1. No. ovigerous females/trap haul	-FSRS traps	- As for Prerecruits
	2. No 71-76 mm ovig females/trap haul		
	3. No. 81-90 mm ovig females/trap haul	-At-sea samples[1]	- As for Prerecruits
Exploitation	1. Estimated total no. of trap hauls	DFO stats + index logs	-Landings (t)/(kg/trap haul) * 1000
	2. Percent in molt group	Port & at-sea samples	-From representative length frequencies
	3. Mean size		-" " " "
	4. [2]F from LCA		-Length-based composition analysis (LCA) model using representative length frequencies
	5. [2]F from change-in-ratio	FSRS trap data	- Claytor and Allard (2003)

[1]For at-sea sample catch rates, size intervals were 50-59, 60-69, 70-76, 70-MLS
[2]F converted to μ in document

Table 8. Landings (mt) by LFA. 2002 and 2003 landings are not all compiled as yet. All statistics from DFO's ZIF database. LFA 27 landings include data for Bay St. Lawrence (within LFA 27 but part of Gulf Region and tracked by Gulf Statistics).

	LFA				
Year	27	28	29	30	Total
1990	3790	8	164	119	4081
1991	3526	9	159	151	3845
1992	2778	9	141	167	3095
1993	2458	12	92	132	2694
1994	2190	13	91	130	2424
1995	2142	15	90	126	2373
1996	1615	14	61	90	1780
1997	1397	12	39	80	1528
1998	1346	12	52	70	1480
1999	1419	5	50	70	1544
2000	1499	5	54	54	1612
2001	1818	5	66	98	1987
Averages					
1991-00*	2037	11	83	107	2238
1981-90	2267	-------210--------			2746
1971-80	787	-------- 70 --------			857
1961-70	802	------- 191--------			993
1951-60	985	------- 505--------			1489
50 yr avg (1951-2000)	1376	--------235--------			1611

*First full decade for which landings for each of LFAs 28, 29 and 30 tabulated separately

Table 9. Landings (mt) by subarea within LFA 27. Northern - Cape St. Lawrence to Ingonish; North-central - Wreck Cove to Pt. Aconi; Central - Alder Pt. to Glace Bay, and Southern - Port Morien to Gabarus (see Fig. 1). Some values are slightly different from Table 5 in Tremblay and Eagles (1998). ZIF database accessed here deemed to best available data. *Central and South combined to equal Stat. Dist. 6 and 7.

Year	Northern	North-central	Central	South
1990	596	532	1308	1245
1991	682	467	1142	1220
1992	584	387	850	946
1993	576	335	783	754
1994	539	294	675	669
1995	564	285	694	598
1996	432	235	524	426
1997	469	196	405	324
1998	416	171	419	345
1999	438	185	407	377
2000	503	214	452	348
2001	573	261	527	470
2002				
Average* 1951-2000	367	205	806	
Average 1991-2000	520	277	635	601

Table 10. Catch rate (kg/trap haul) from voluntary fishing logs in subareas of LFA 27. Shown is mean, lower and upper 95% confidence intervals (LCL and UCL), and n (number of logs). All logs included.

	Northern				North-central				Central				South			
Year	Mean	LCL	UCL	n	Mean	LCL	UCL	n	Mean	LCL	UCL	n	Mean	LCL	UCL	n
1992	0.45	0.40	0.50	9	0.53	0.34	0.72	3	0.47	0.40	0.54	6	0.63	0.56	0.69	9
1993	0.45	0.39	0.52	12	0.51	0.45	0.56	15	0.47	0.41	0.53	8	0.54	0.49	0.59	8
1994	0.40	0.33	0.47	15	0.45	0.41	0.50	13	0.36	0.32	0.40	9	0.48	0.43	0.52	11
1995	0.38	0.34	0.42	19	0.48	0.44	0.53	11	0.40	0.34	0.46	10	0.42	0.38	0.46	13
1996	0.31	0.27	0.34	18	0.43	0.38	0.48	10	0.35	0.29	0.41	10	0.31	0.28	0.33	12
1997	0.36	0.32	0.39	18	0.39	0.32	0.46	8	0.29	0.25	0.33	9	0.24	0.21	0.27	13
1998	0.35	0.30	0.40	16	0.41	0.34	0.47	9	0.31	0.27	0.36	9	0.28	0.24	0.32	12
1999	0.33	0.27	0.39	11	0.40	0.34	0.46	10	0.30	0.27	0.33	7	0.31	0.26	0.36	10
2000	0.38	0.33	0.44	12	0.50	0.42	0.57	10	0.35	0.30	0.40	6	0.33	0.28	0.38	8
2001	0.40	0.33	0.46	11	0.47	0.37	0.56	9	0.31	0.28	0.34	7	0.34	0.30	0.39	8
2002	0.39	0.33	0.45	10	0.38	0.31	0.45	9	0.32	0.26	0.37	7	0.29	0.25	0.34	8
2003	0.47	0.36	0.58	9	0.44	0.34	0.55	8	0.35	0.31	0.38	4	0.36	0.28	0.44	5

Table 11. Catch rate (kg/trap haul) from voluntary fishing logs in LFAs 29 and 30. Shown is mean, lower and upper 95% confidence intervals (LCL and UCL), and n (number of logs). All logs included.

	LFA 29				LFA 30			
	Mean	LCL	UCL	n	Mean	LCL	UCL	n
1992	0.27	0.22	0.33	7	0.80	0.72	0.89	7
1993	0.20	0.16	0.24	8	0.70	0.62	0.78	6
1994	0.21	0.17	0.25	10	0.63	0.52	0.73	6
1995	0.20	0.16	0.24	7	0.57	0.46	0.67	6
1996	0.15	0.11	0.20	6	0.46	0.39	0.53	7
1997	0.13	0.10	0.17	5	0.34	0.30	0.37	7
1998	0.13	0.10	0.15	4	0.43	0.39	0.47	4
1999	0.11	0.09	0.13	4	0.40	0.33	0.46	4
2000	0.14	0.10	0.18	4	0.34	0.32	0.36	4
2001	0.15	0.13	0.17	3	0.45	0.37	0.52	4
2002	0.14	0.13	0.14	2	0.38	0.33	0.44	4
2003	0.22	0.20	0.25	2	0.44	0.38	0.50	4

Table 12. Summary of trends for different indicators by LFA and subarea. Years considered follow indicator. ↑ = clear increase; ↓ = clear decrease; ↗ = variable but increased; ↙ = variable but decreased; → no clear trend.
Mark = Market size class. MLS = minimum legal size. Ov = ovigerous. At-sea Ov 70-76 npth* = weeks 1-3 only considered.

Indicator	27 All	27-N	27 NC	27 C	27 S	28	29	30
Landings								
1997-2001	↑	↑	↑	↑	↑	↓	↑	↑
Compared to 10 yr mean	↙	↗	↙	↓	↓	↓	↓	↓
Compared to 50 yr mean	↑	↑	↑	↑	↑		↓	
Legal Sizes								
Log Legal cpue (kg/th) 97-03	↑	↑	→	↗	↑	-	↑	↗
Log Mark cpue (kg/th) 97-03	↑	↑	↑	↑	↑	-	-	-
FSRS Legal npth 99-03	→	↑	↓	↙	→	↑	↑	→
FSRS Mark npth 99-03	↑	↑	→	↑	↗	-	-	-
At-sea Legal npth 97-03		-	↗	-	-	-	-	↓
At-sea Mark npth 97-03		-	↑	-	-	-	-	-
Prerecruits								
FSRS 51-60 npth 99-03	→	→	→	↗	→	↓	↑	↑
FSRS 61-70 npth 99-03	↙	↓	↓	→	→	→	↑	→
FSRS 71-MLS npth 99-03	↑	↑	↑	↑	↑	→	↑	→
At-sea 51-60 npth 97-03		-	↙	-	-	-	-	-
At-sea 61-70 npth 97-03		-	↓	-	-	-	-	↑
At-sea 71-MLS npth 97-03		-	↑	-	-	-	-	→
Spawners								
FSRS Ov 71-75 npth 99-03	↗	↑	→	↙	↗	↗	↗	→
FSRS Ov 81-90 npth 99-03		↑	↙	↙	↑	→	↙	↓
FSRS Ov (all) npth 99-03	→	↑	↙	↓	→	↙	→	↓
At-sea Ov 71-75 npth 97-03		-	↗	-	-	-	-	-
At-sea Ov 81-90 npth 97-03		-	↗	-	-	-	-	↓
At-sea Ov (all) npth 97-03		-	↑	-	-	-	-	↓
Exploitation								
Effort (n trap hauls) 97-03	→	→	→	↗	→	-	↗	↗
% in 1st molt group 97-03	↗	↗	→	→	↗	-	↗	↑
Mean size 97-03	↑	↑	↑	↑	↑	-	↓	↓
F – LCA 97-03	↓	↓	↓	↓	↙	-	→	↑
F- Change-in-ratio 99-03			↙		↙	-	-	-

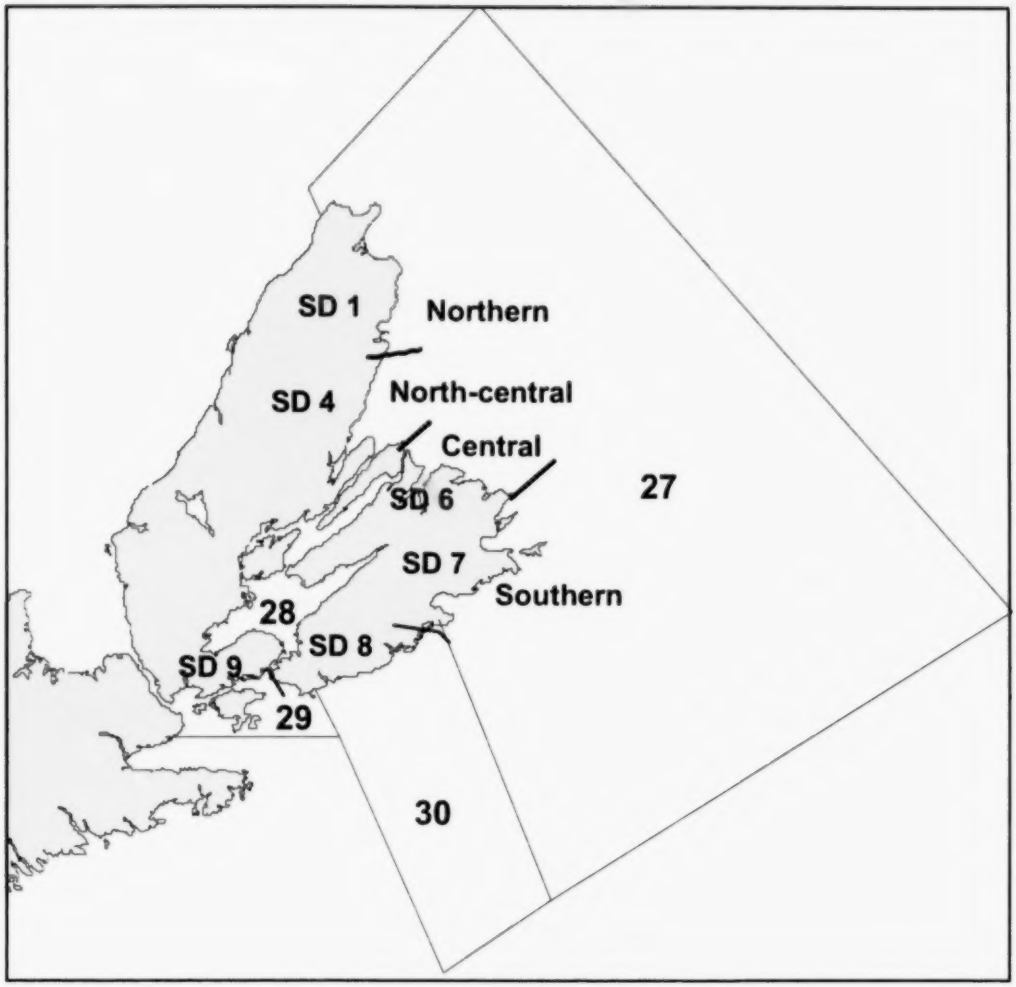


Figure 1. Eastern Cape Breton Lobster Fishing Areas (LFA's) 27, 28, 29 and 30. SD is statistical district. Subareas in LFA 27 (Northern, North-central, Central and Southern) are for assessment purposes only. They correspond to SD except for the Central/Southern dividing line.

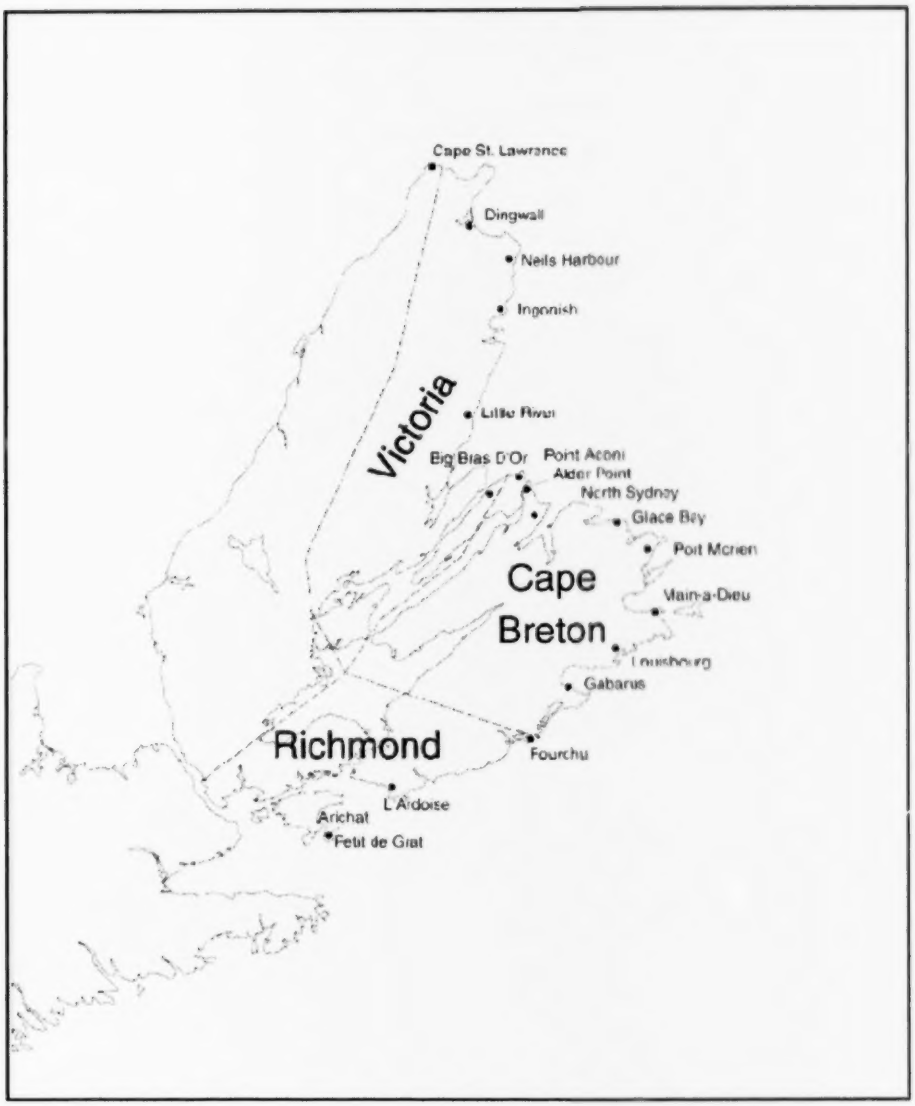


Figure 2. Eastern Cape Breton counties and selected place names.

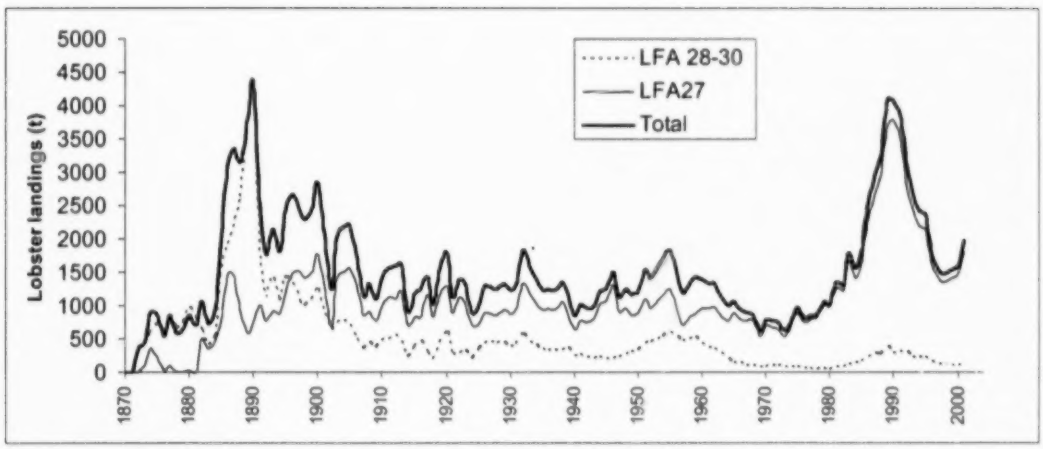
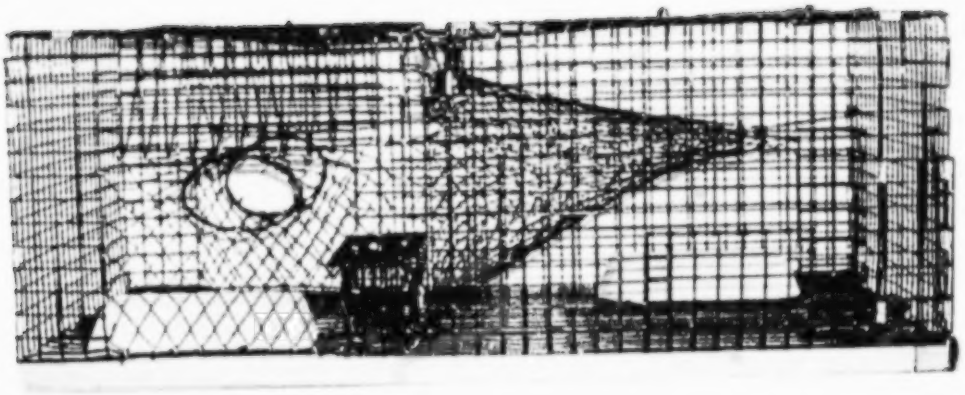
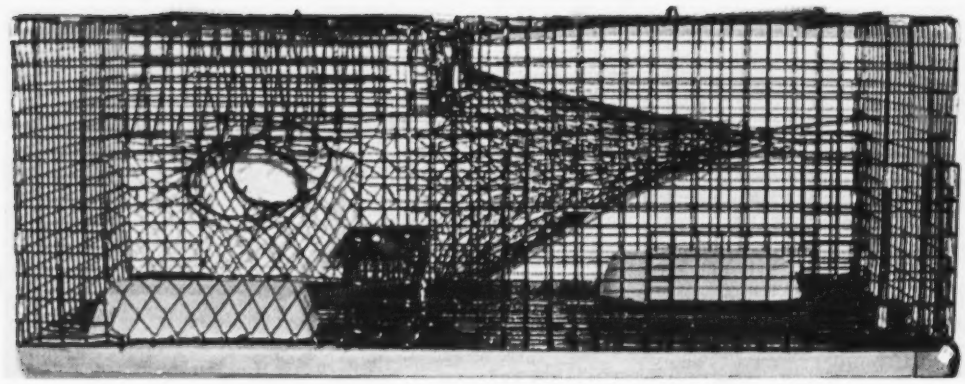


Figure 3. Historical lobster landings for LFAs off eastern Cape Breton from Williamson (1992) and Commercial Data Division, DFO. From 1947 to the present landings were compiled by LFA; prior to 1947, landings were compiled by county only. Since LFA 27 is comprised of Victoria and Cape Breton Counties, landings for this LFA are continuous back to the 1870s. LFAs 28-30 are nearly the same as Richmond County but include a slightly larger area. LFAs 28-30 exceeded Richmond County by an average factor of 1.16 during the period 1947-1989 when both county and LFA landings were available. Therefore to get LFA 28-30 landings prior to 1947, the Richmond County landings were increased by 1.16.



Dimensions: 101.6 cm by 35.6 cm by 53.3 cm (40" by 21" by 14")
Mesh size: 2.5 cm (1")
Entrance ring: 12.7 cm (5")

Figure 4. Fishermen and Scientists Research Society (FSRS) recruitment trap and gauge.



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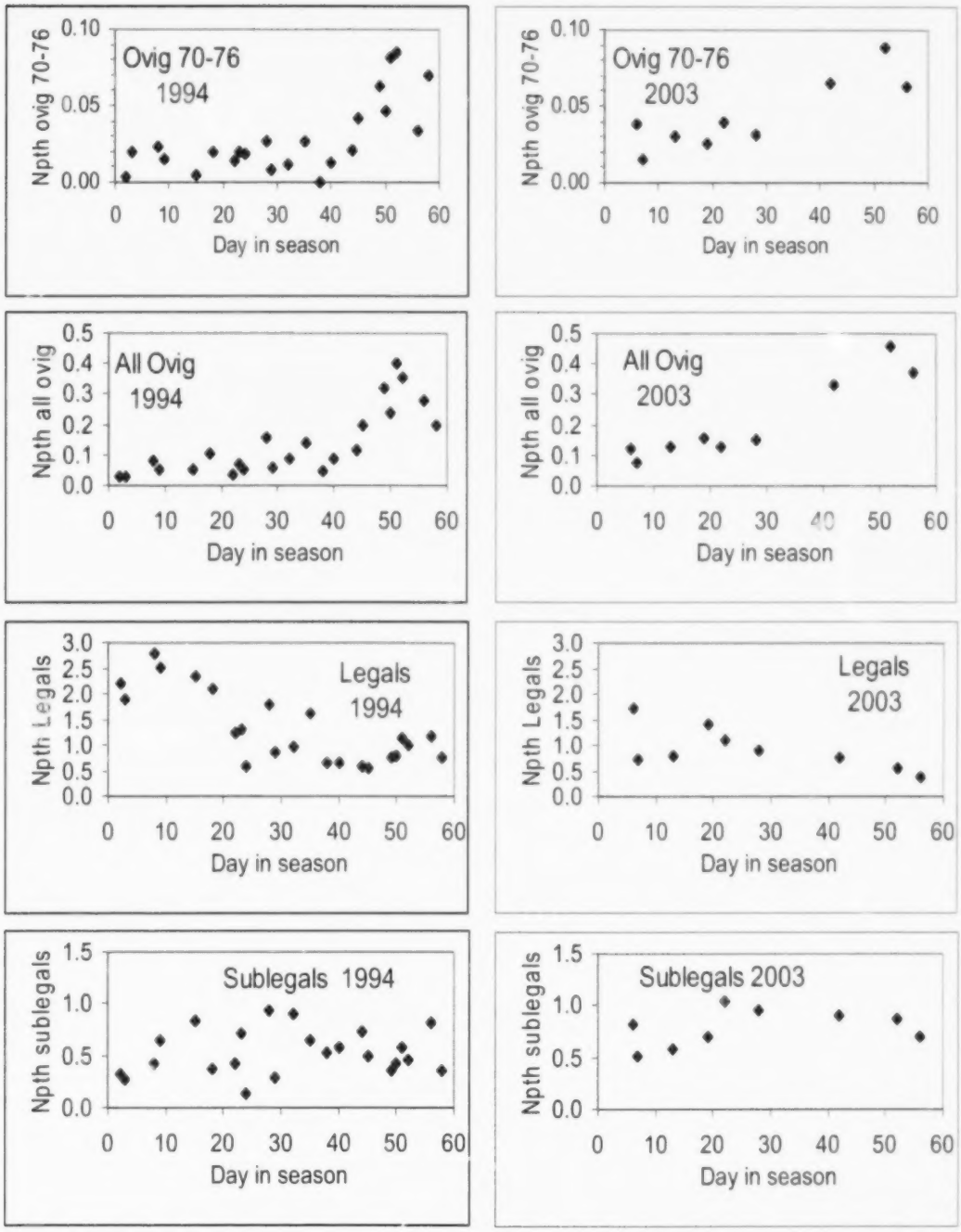


Figure 5. Number per trap haul (Number per trap haul or Npth) within season of ovigerous females, legal sizes and sub-legal sizes. Data are from at-sea samples off Little River (North-Central subarea)

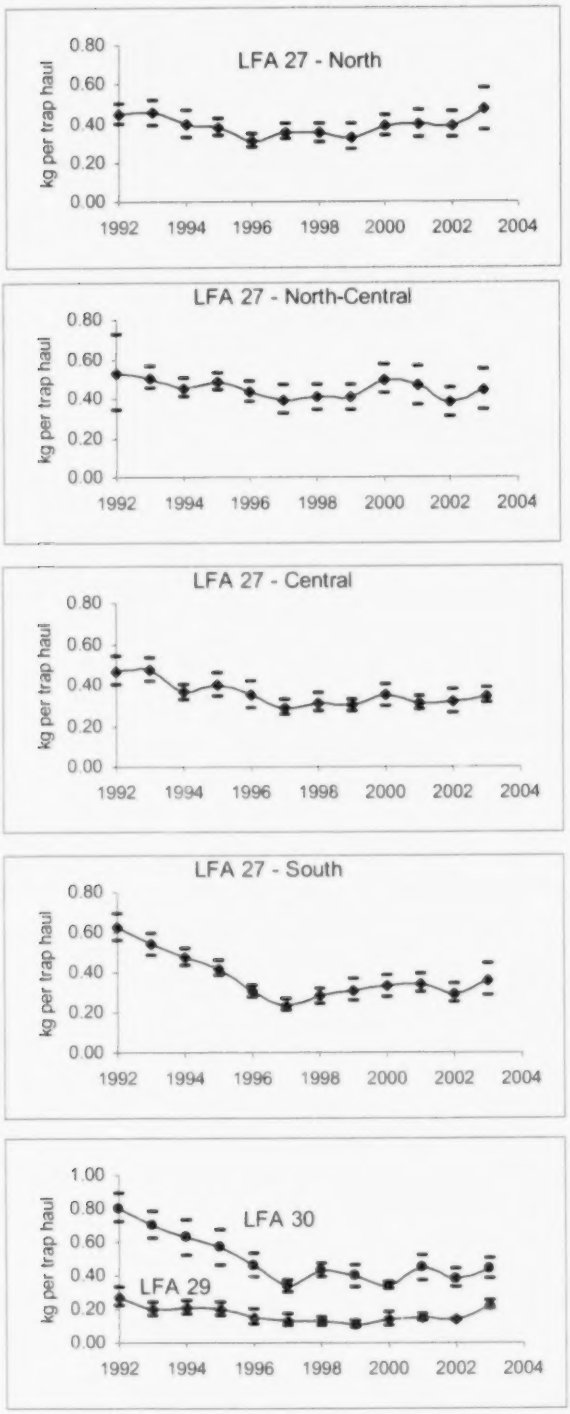


Figure 6. Commercial catch rate (kg/trap haul) from voluntary fishing logs. Bars show 95% confidence intervals. For number of logs per year see Tables 7 and 8.

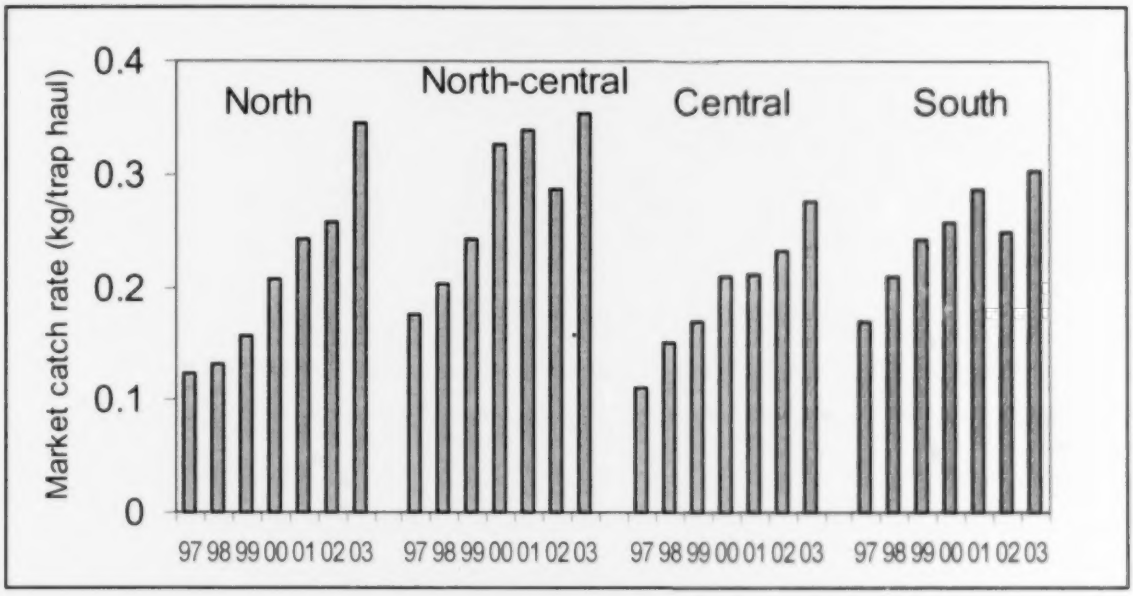
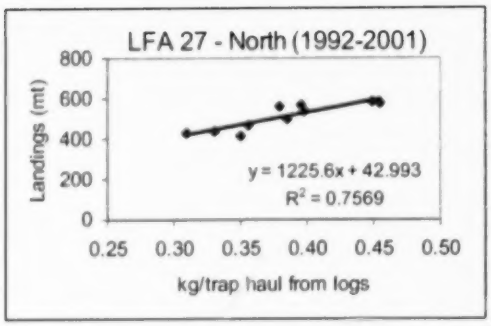
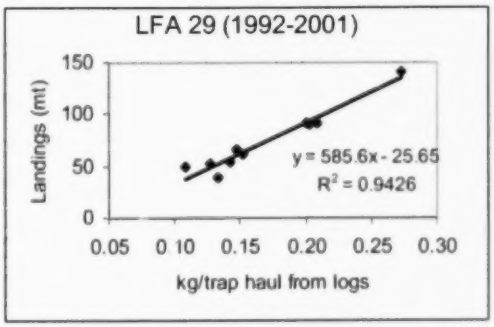
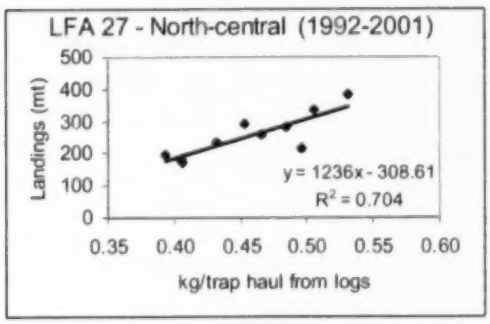
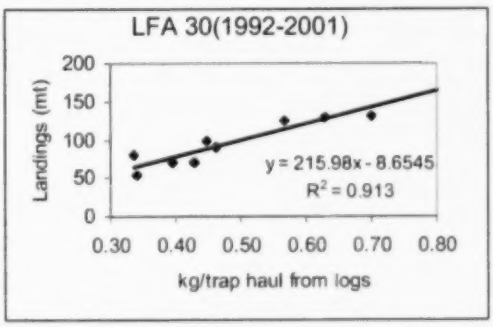


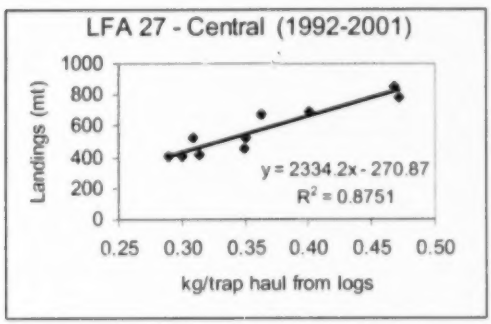
Figure 7. Catch rate of Market size lobsters (>= 81 mm CL) within each subarea of LFA 27, 1997-2003. Based on weight of commercial landings from voluntary reporting logs.











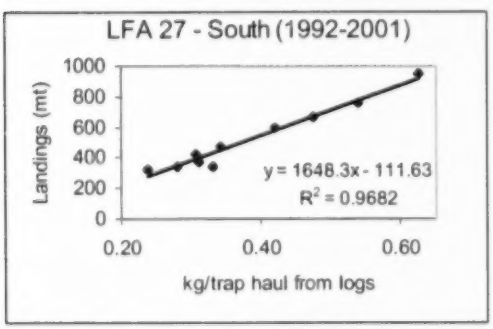


Figure 8. Regressions of landings from all mandatory logs on catch rates derived from voluntary logs. Last 2 years of landings data from mandatory are not up to date and not included here.

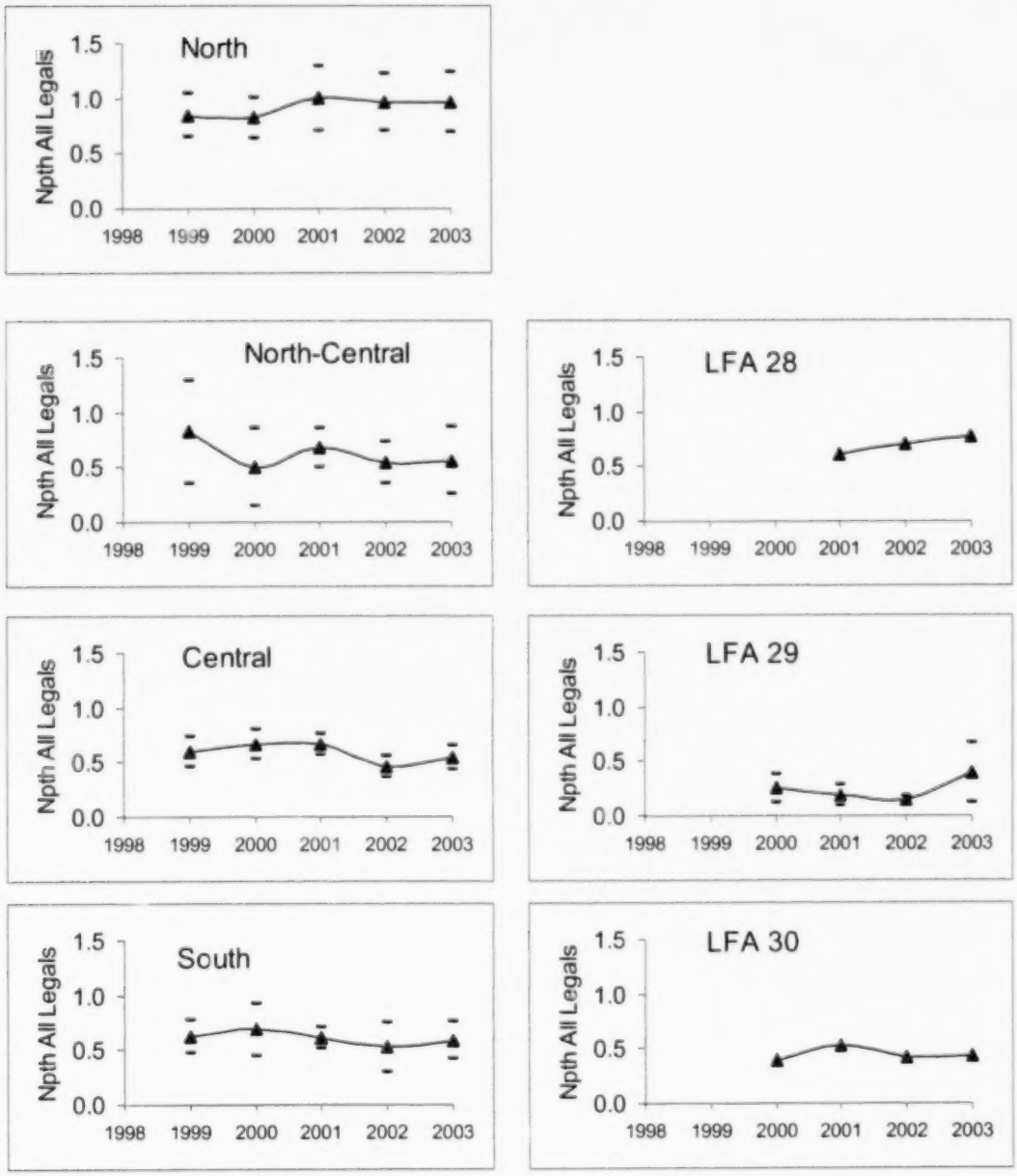


Figure 9. Catch rate (number per trap haul or Npth) of legal sizes in LFAs 27-30 from FSRS traps. LFA 27 subareas in left panels. Bars are 95% C.I.

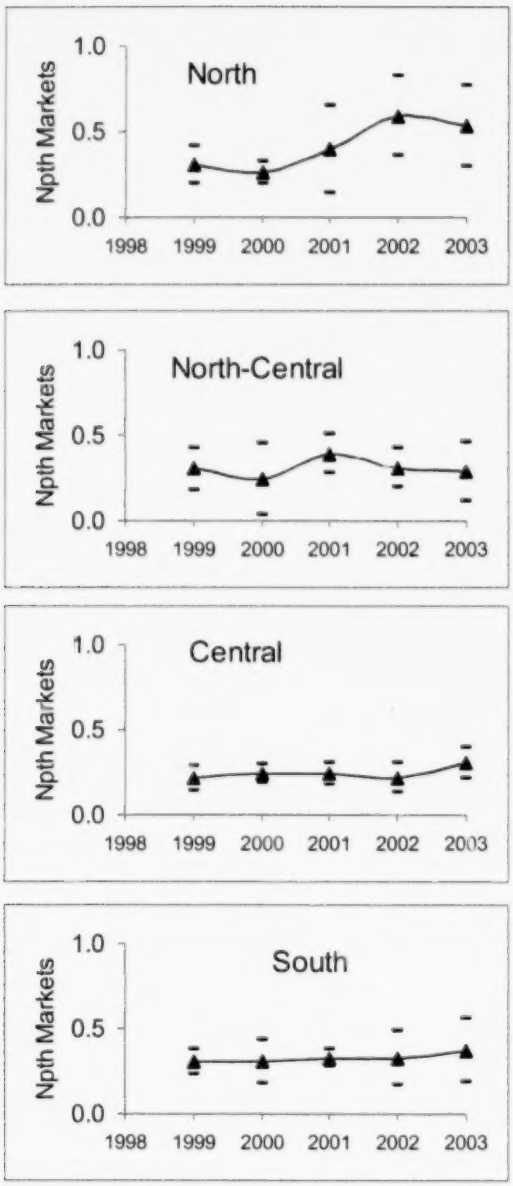


Figure 10. Catch rate (number per trap haul or Npth) of market sizes (>=81 mm CL) in FSRS recruitment traps for subareas in LFA 27. LFA 27 subareas in left panels. Bars are 95% C.I.

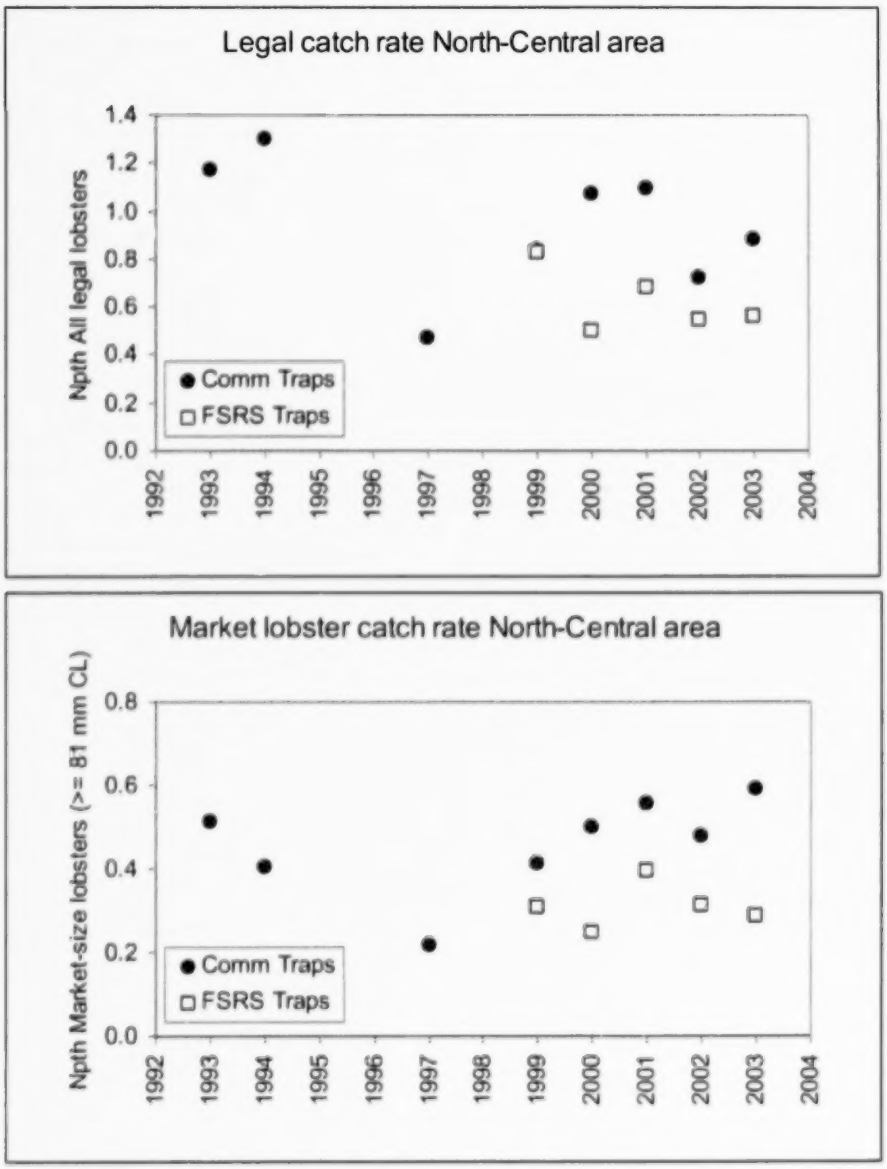


Figure 11. Annual catch rate (number per trap haul or Npth) of legal and market-sized lobsters estimated from (i) Little River at-sea samples of commercial traps, and (ii) FSRS traps. At-sea sample catch rates estimates are for day 30 in the season based on regressions of npth on day in the season.

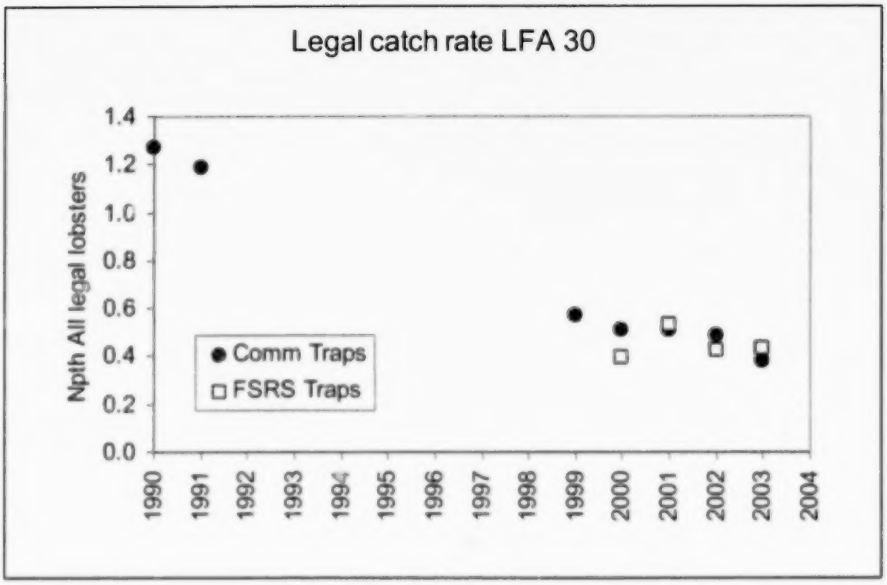


Figure 12. Annual catch rate (number per trap haul or Npth) of legal lobsters estimated from (i) Fourchu at-sea samples of commercial traps, and (ii) FSRS traps. At-sea sample catch rates estimates are for day 30 in the season based on regressions of npth on day in the season.

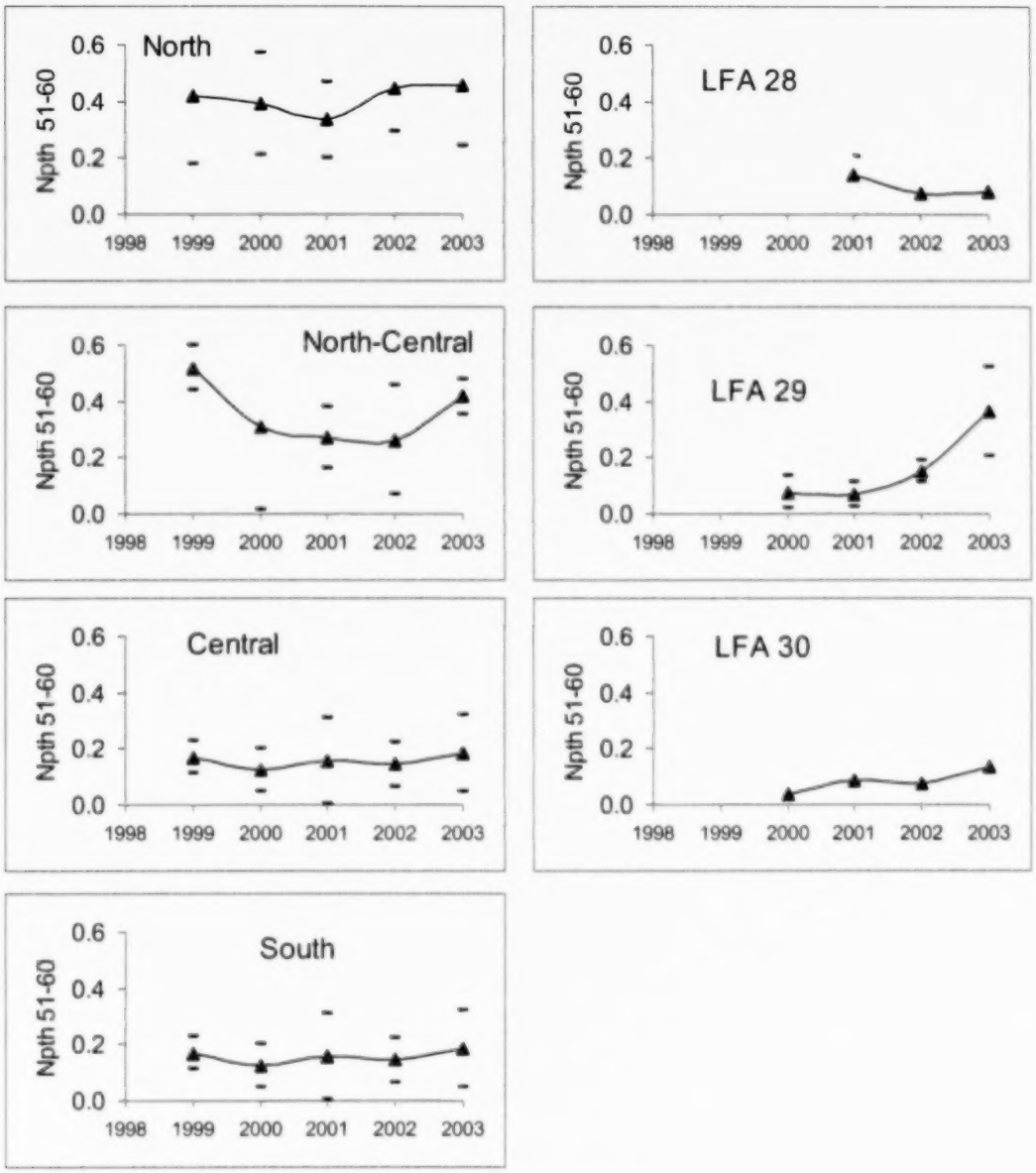


Figure 13. Catch rate (number per trap haul or Npth) of prerecruit lobster 51-60 mm CL in LFAs 27-30 from FSRS traps. LFA 27 subareas in left panels. Bars are 95% C.I. Only lower confidence limit is shown if upper exceeds scale. Includes ovigerous females.

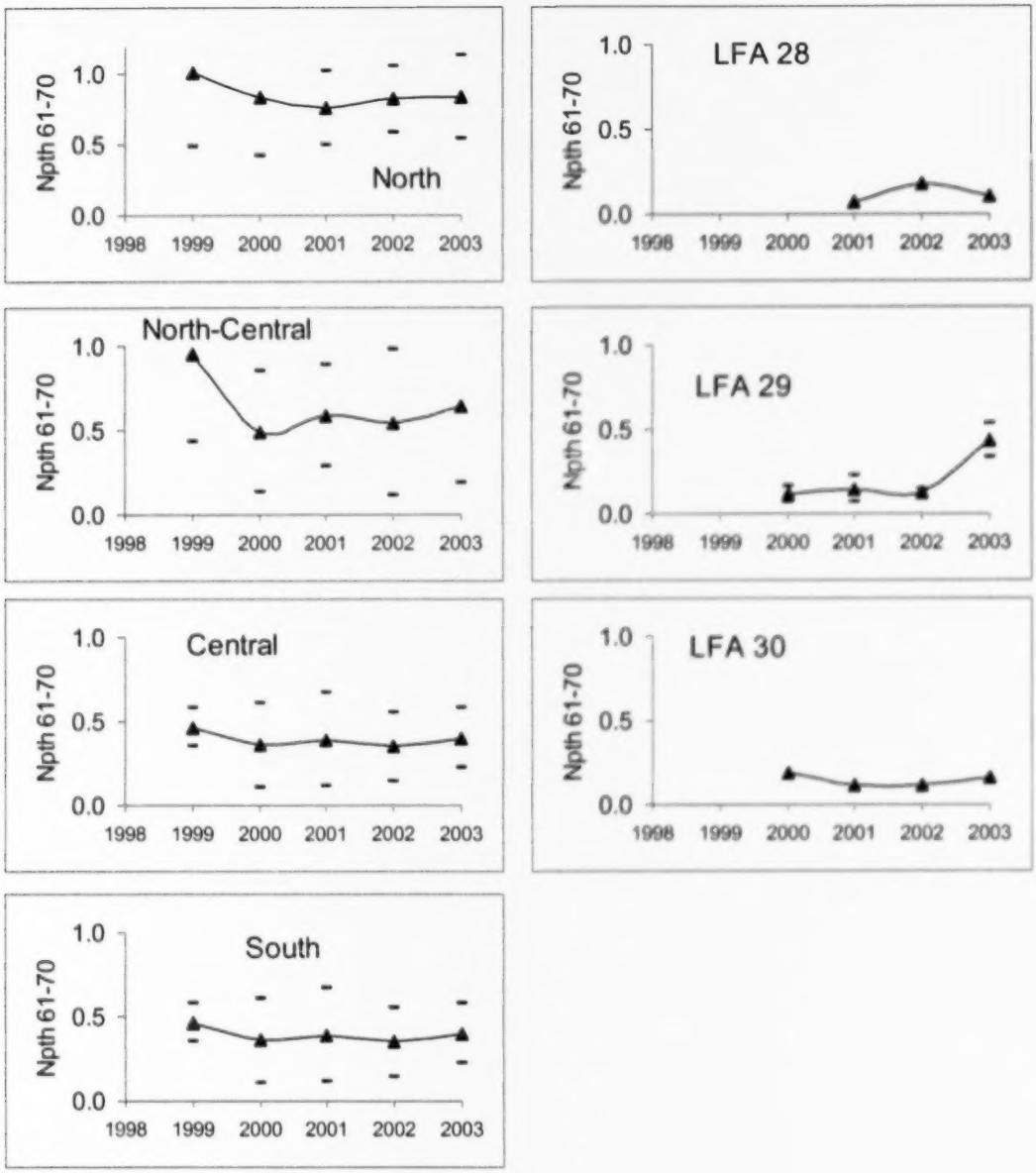


Figure 14. Catch rate (number per trap haul or Npth) of prerecruit lobster 61-70 mm CL in LFAs 27-30 from FSRS traps. LFA 27 subareas in left panels. Bars are 95% C.I. Only lower confidence limit is shown if upper exceeds scale. Includes ovigerous females.

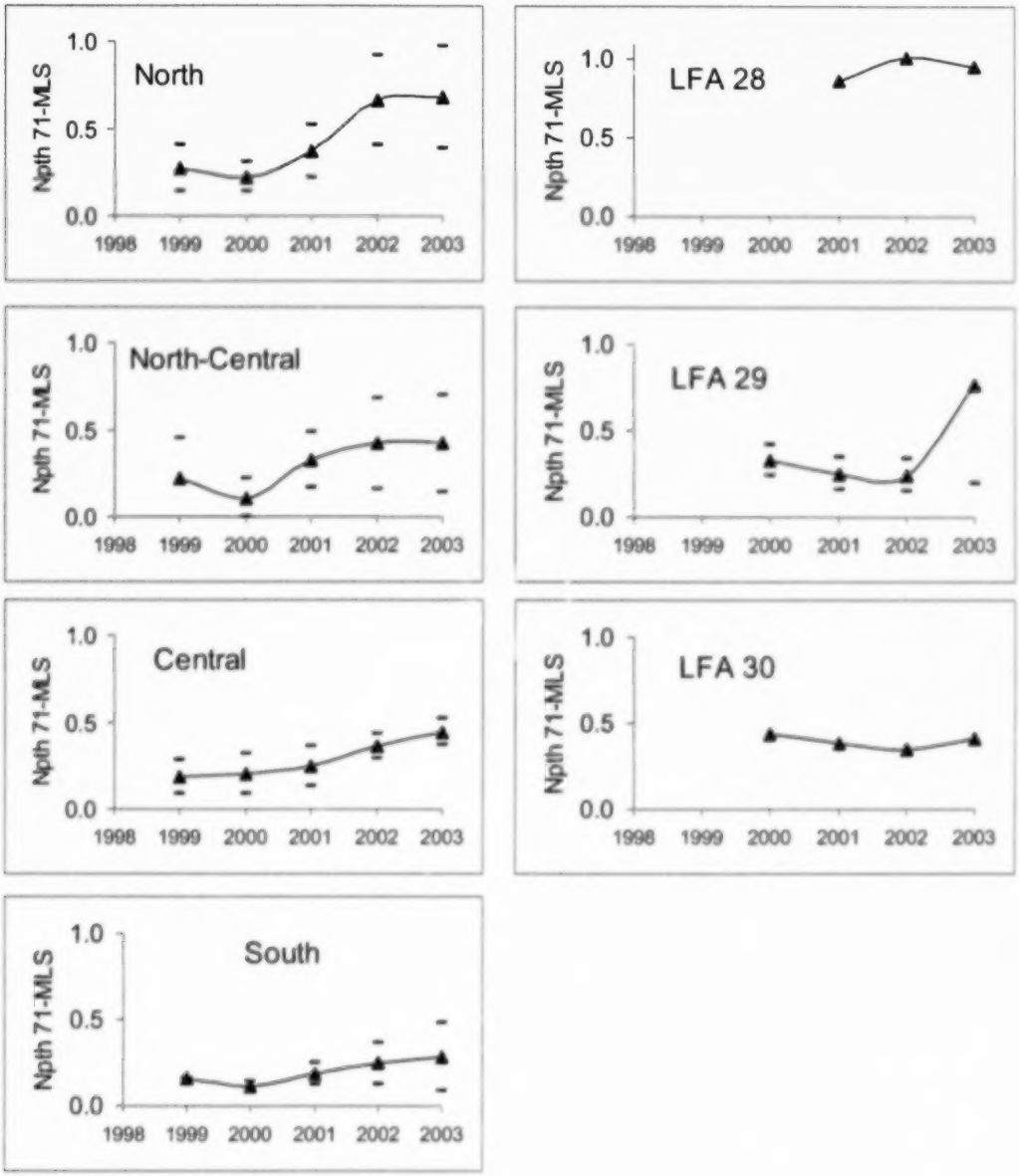


Figure 15. Catch rate (Number per trap haul or Npth) of prerecruit lobster 71 mm to MLS in LFAs 27-30 from FSRS traps. For LFA MLS was 73 mm in 1999-2000, 74.5 mm in 2001 and 76 mm in 2002-2003. In LFA 30 MLS was 82.5 mm CL; in LFAs 28-29 MLS was 84 mm CL. Also shown is 95% C.I. Includes ovigerous females.

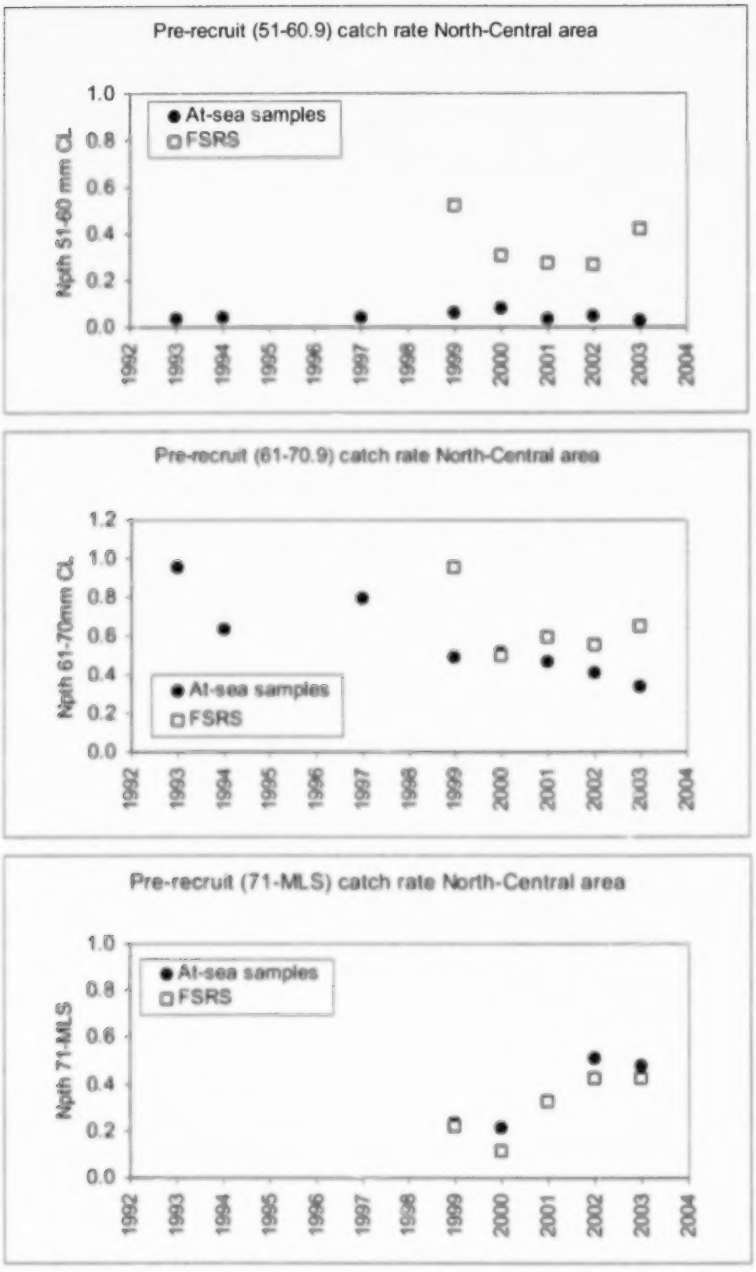


Figure 16. Prerecruit indicators (number per trap haul or Npth) for North-Central area from at-sea commercial samples in comparison with FSRS trap indicators. Shown are 3 prerecruit size groups. At-sea sample catch rates estimates are for day 30 in the season based on regressions of npth on day in the season. Includes ovigerous females.

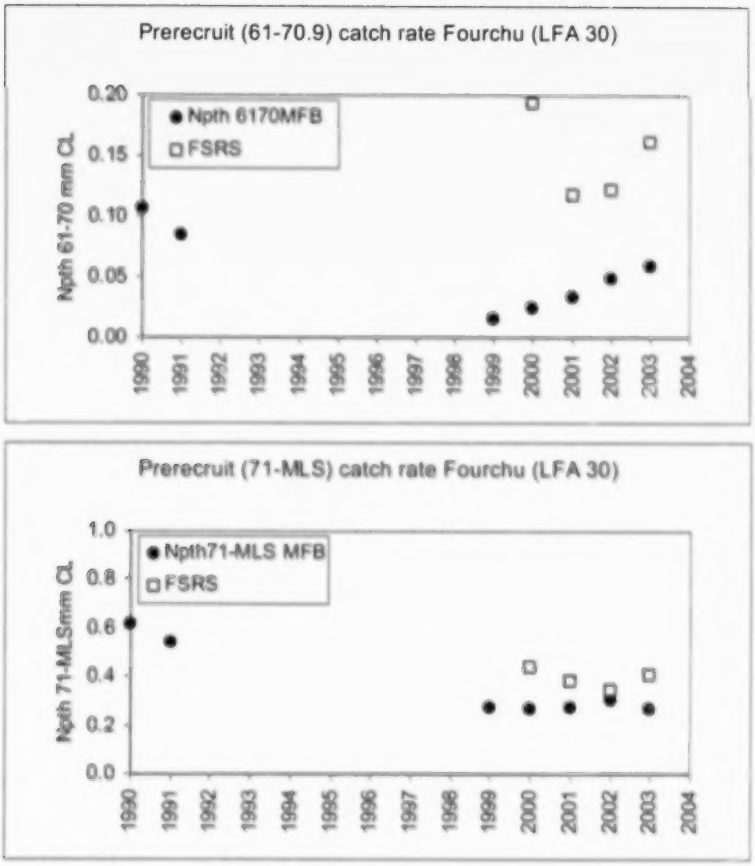


Figure 17. Prerecruit indicators (number per trap haul or Npth) for LFA 30 based on at-sea samples in comparison with indictor based on FSRS traps. At-sea sample catch rates estimates are for day 30 in the season based on regressions of npth on day in the season. Includes ovigerous females.

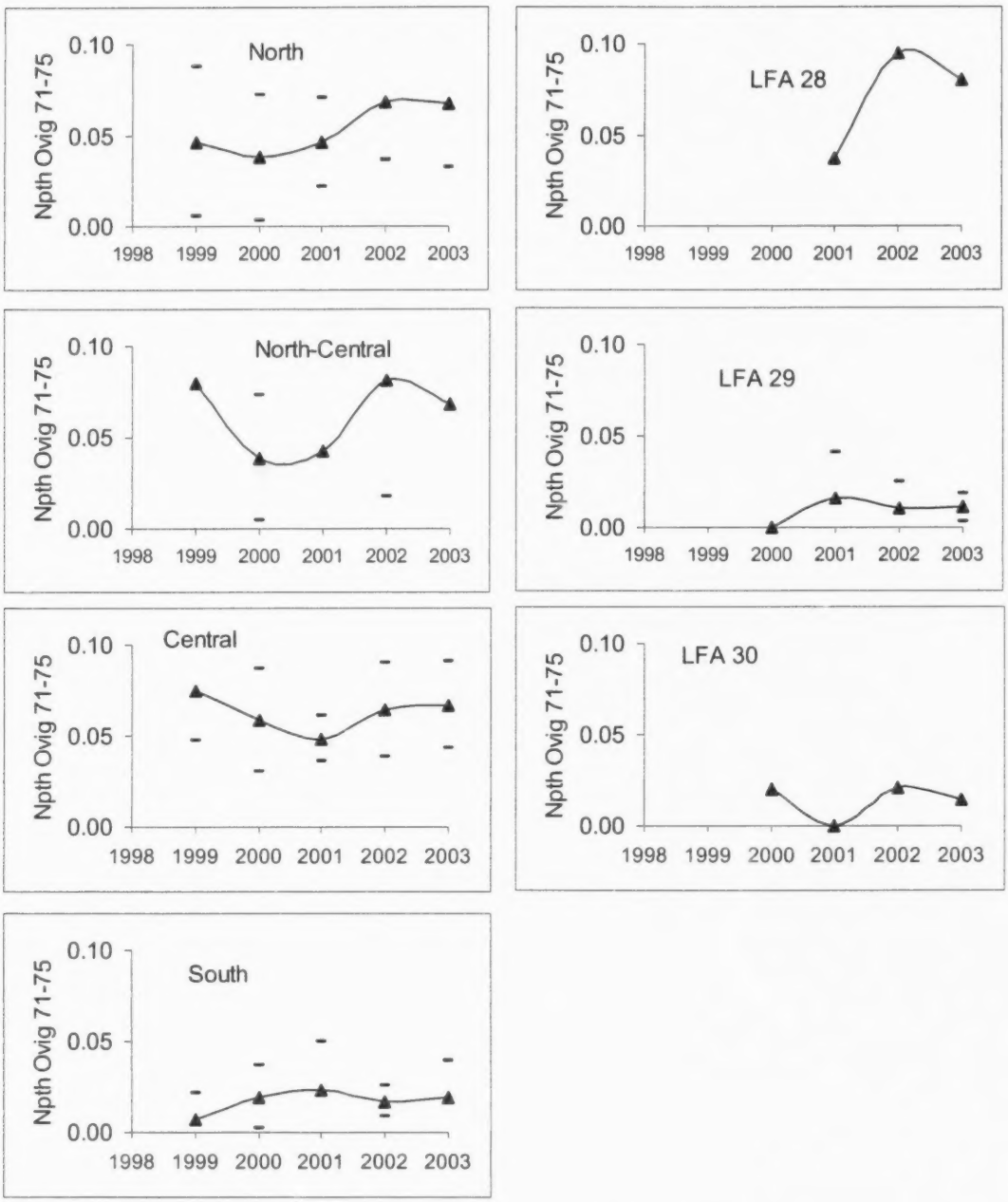


Figure 18. Catch rate (Number per trap haul or Npth) of ovigerous females 71-75.9 mm CL in LFAs 27-30 from FSRS traps. LFA 27 subareas in left panels. Bars are 95% C.I.

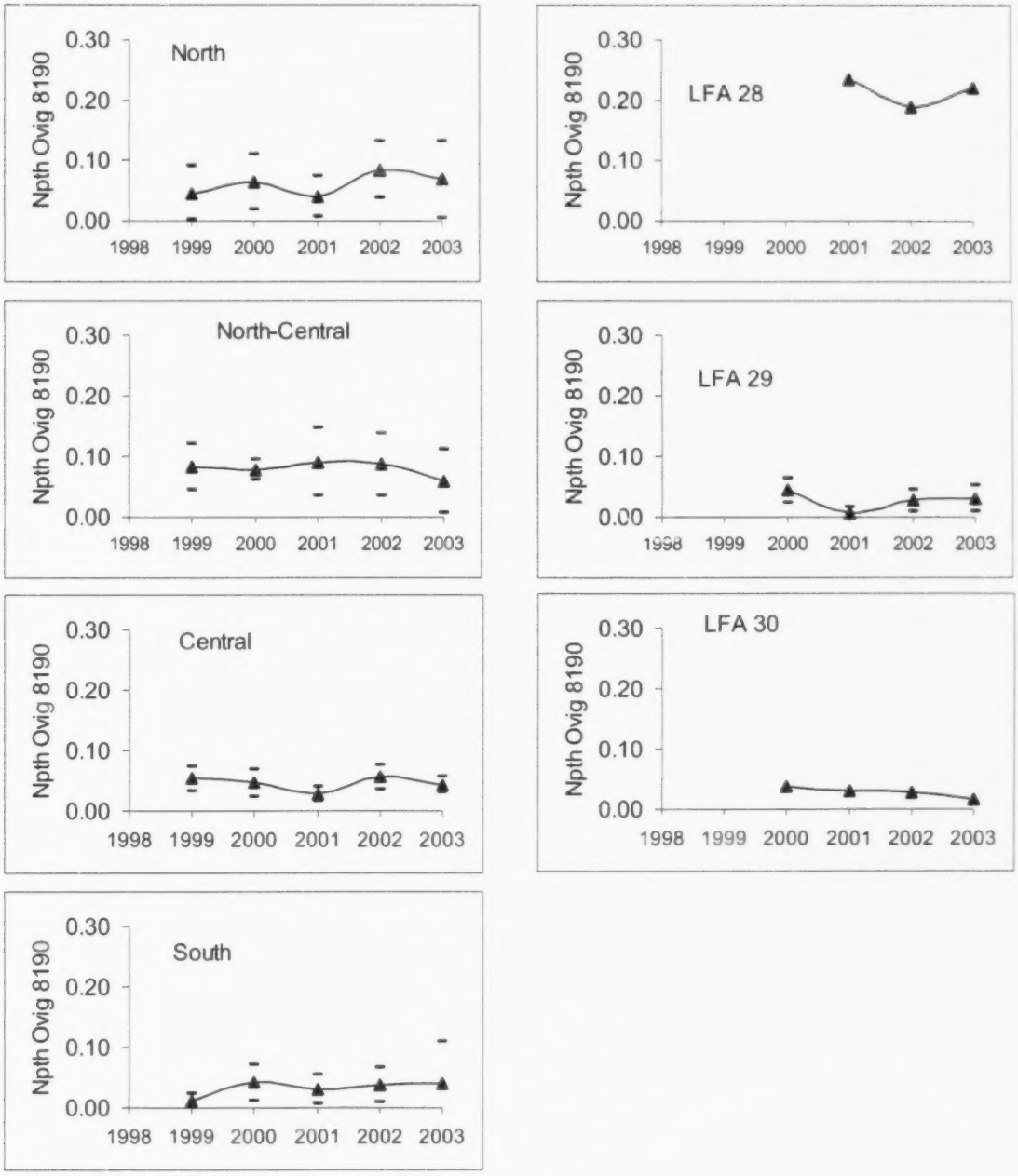


Figure 19. Catch rate (Number per trap haul or Npth) of ovigerous females 81-90 mm CL in LFAs 28-30 from FSRS traps. Bars are 95% C.I.

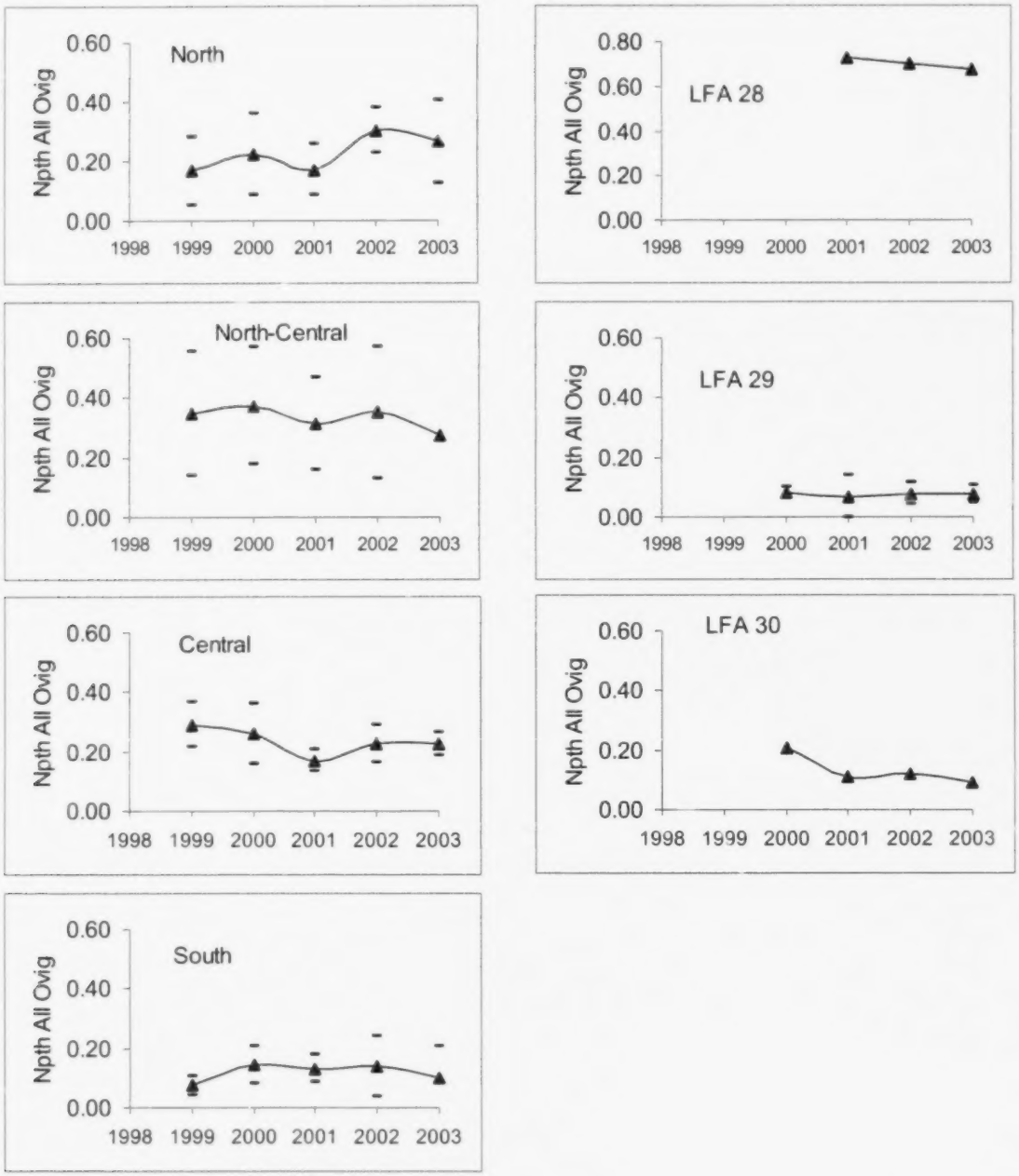


Figure 20. Catch rate (Number per trap haul or Npth) of all sizes of ovigerous females in LFAs 27-30 from FSRS traps. LFA 27 subareas in left panels. Bars are 95% C.I. Note different scale for LFA 28.

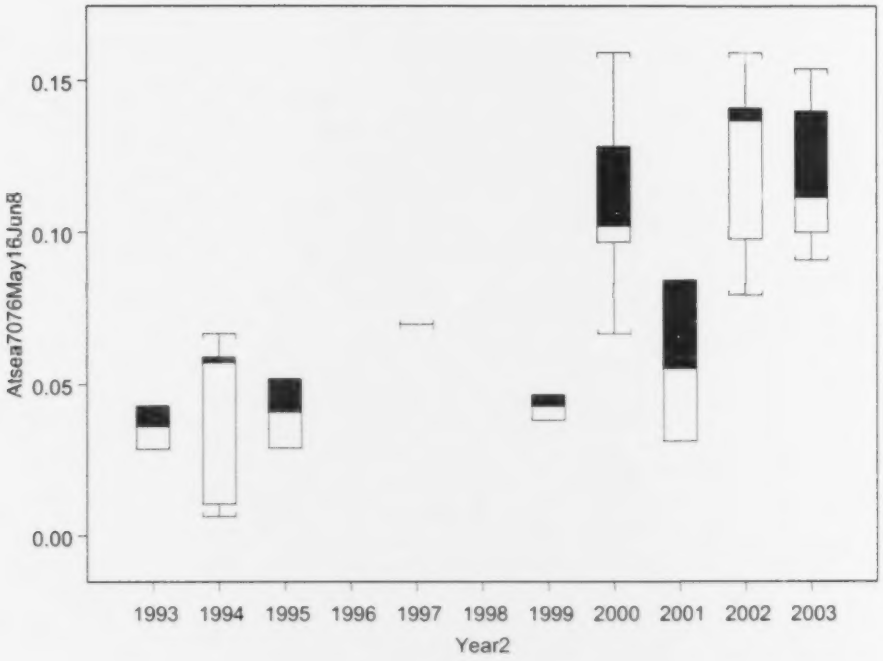


Figure 21. Boxplot of percentage of females 70-76 mm CL that are ovigerous from Little River at-sea samples, 1993-2003. Only samples from May 16-June 8th included. Median is at dividing line between black portion and white portion of rectangles; upper and lower edges of rectangle are quartiles (containing 25% of observations); fences show extent of data beyond quartiles.

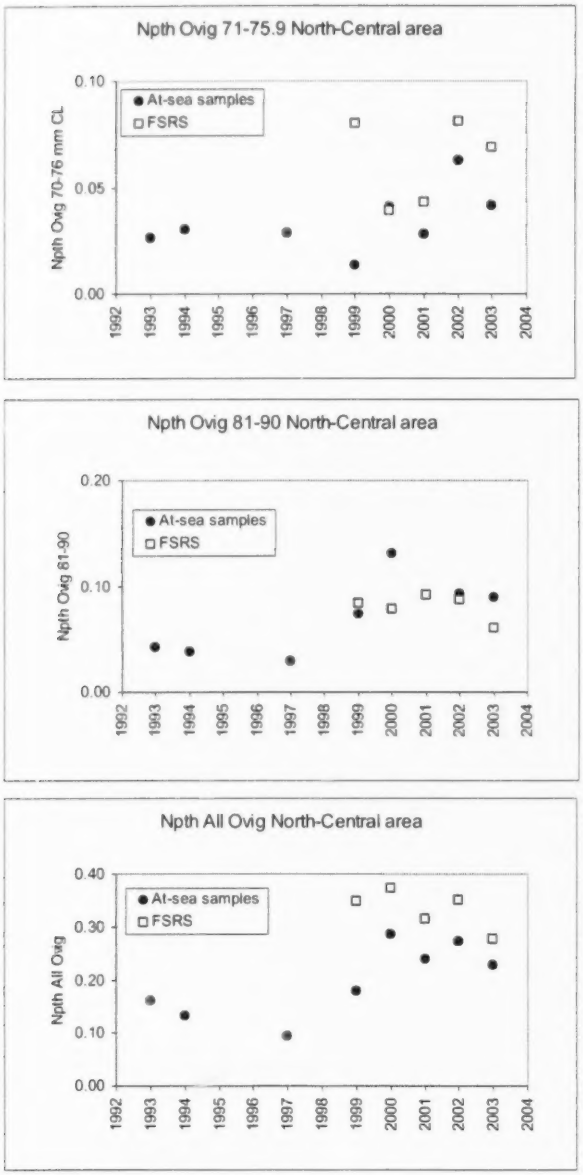


Figure 22. Ovigerous female (71-75.9, 81-90 and all sizes) indicators for North-central subarea of LFA 27. Based on at-sea samples of the commercial catch and FSRS traps. At-sea sample catch rates estimates are for day 30 in the season based on regressions of npth on day in the season. Note different scales.

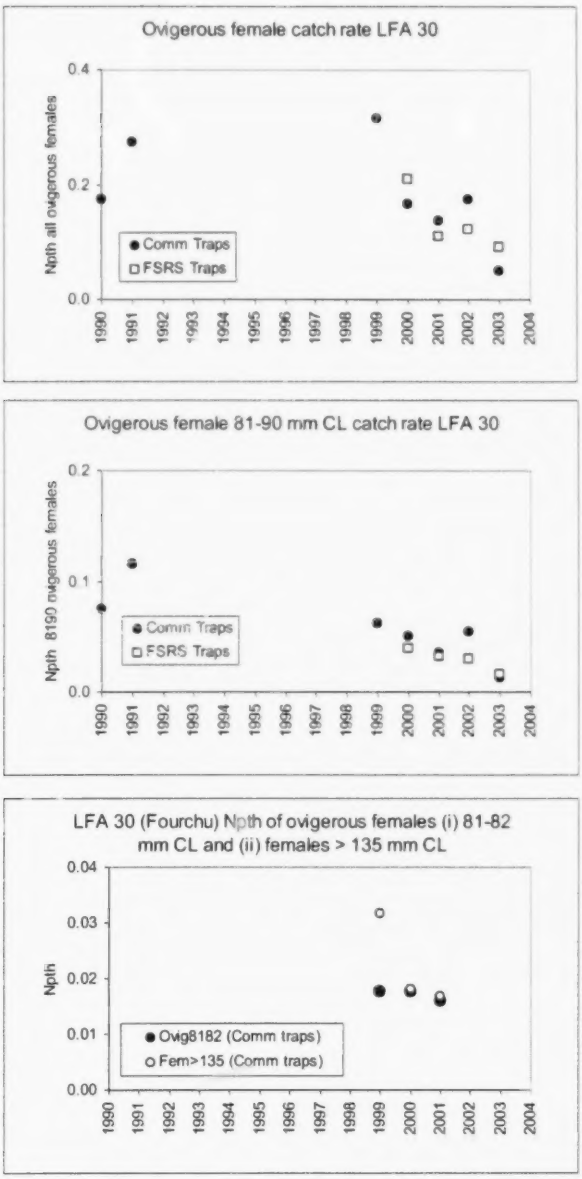


Figure 23. Indicators for ovigerous females and females > 135 mm CL in LFA 30 based on at-sea samples (commercial traps) and FSRS traps. Upper panel shows ovigerous females (all sizes); middle panel shows catch rate of ovigerous females 81-90 mm CL and lower panel shows ovigerous females 81-82 mm CL and females > 135 mm CL. At-sea sample catch rates estimates are for day 30 in the season based on regressions of npth on day in the season. In lower panel only years 1999-2001 are shown because of exceedingly low numbers of these groups in at-sea samples.

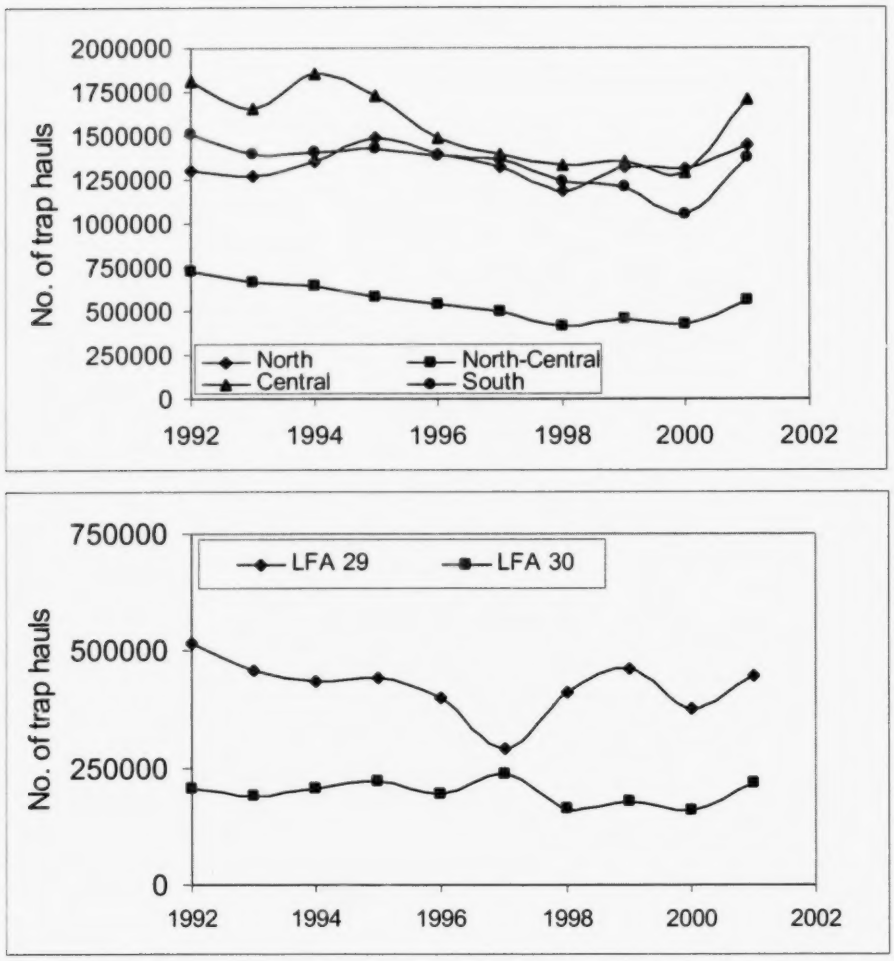


Figure 24. Annual effort (number of trap hauls) for LFAs 27, 29 and 30. Derived by dividing landings by average catch rate from voluntary logs.

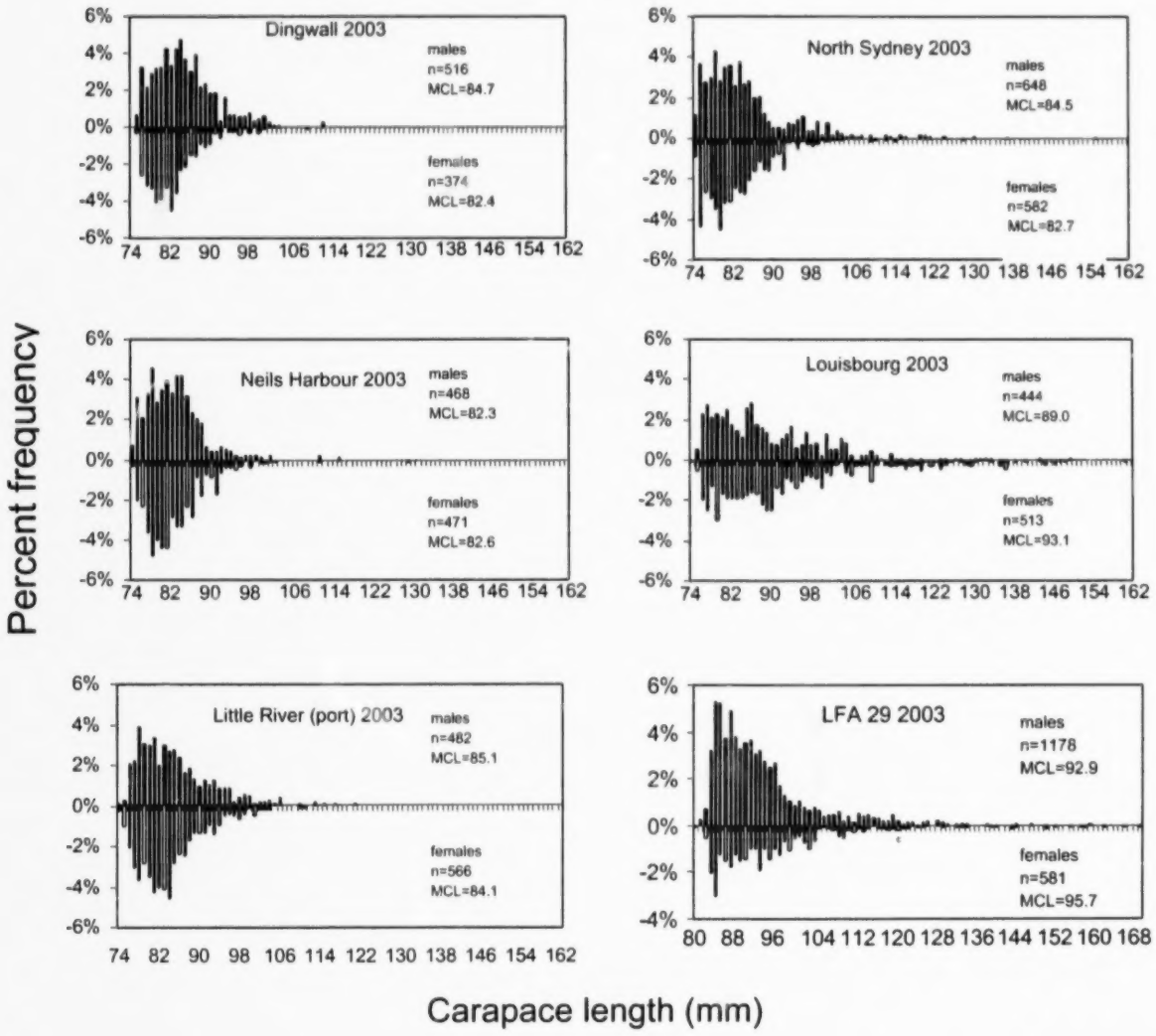


Figure 25. Size frequency distributions of lobsters measured in port samples in 2003. No weighting applied. Note different scale for carapace length for LFA 29 plot.

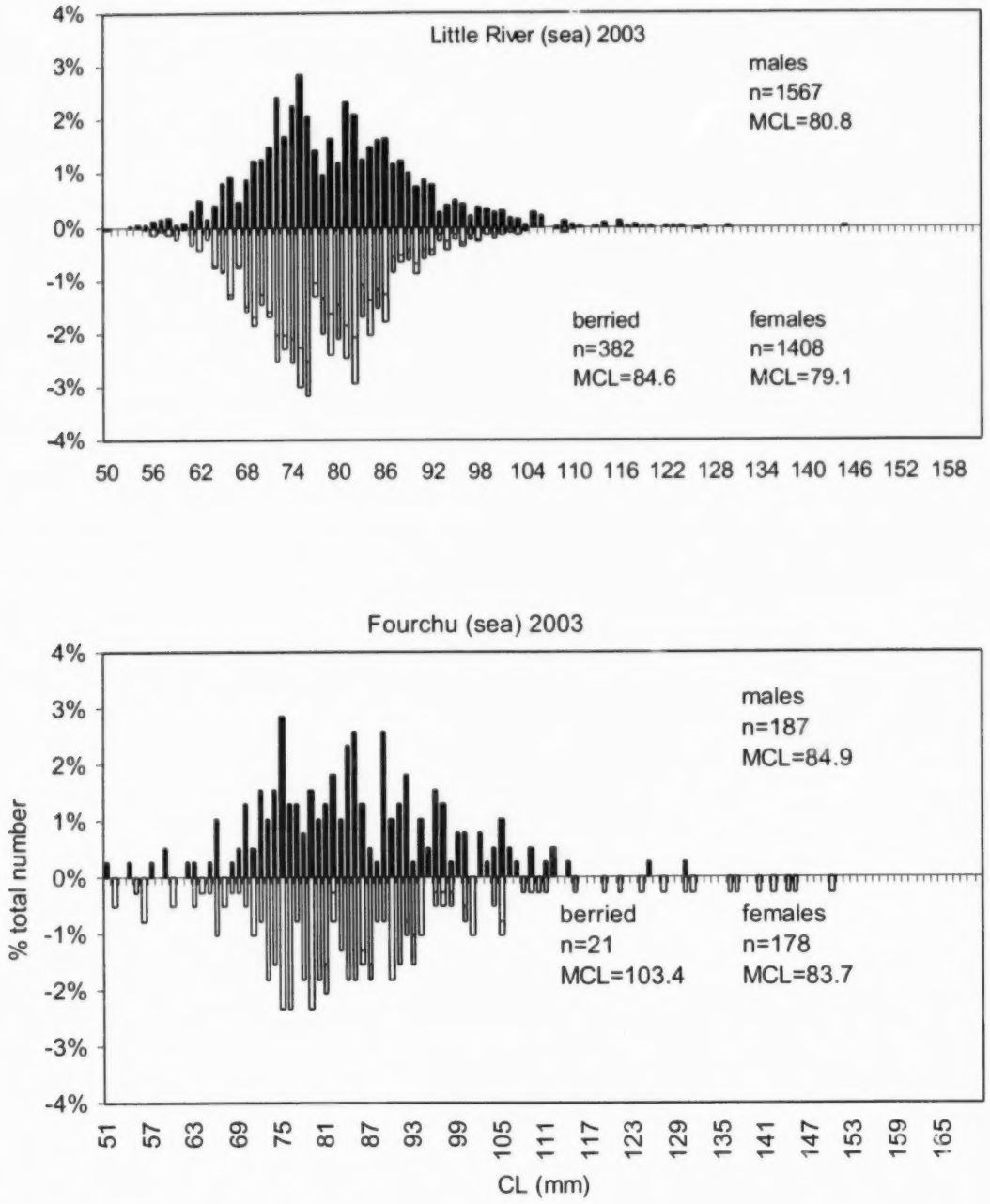


Figure 26. Size frequency distribution of lobsters measured during at-sea samples off Litter River and Fourchu in 2003.

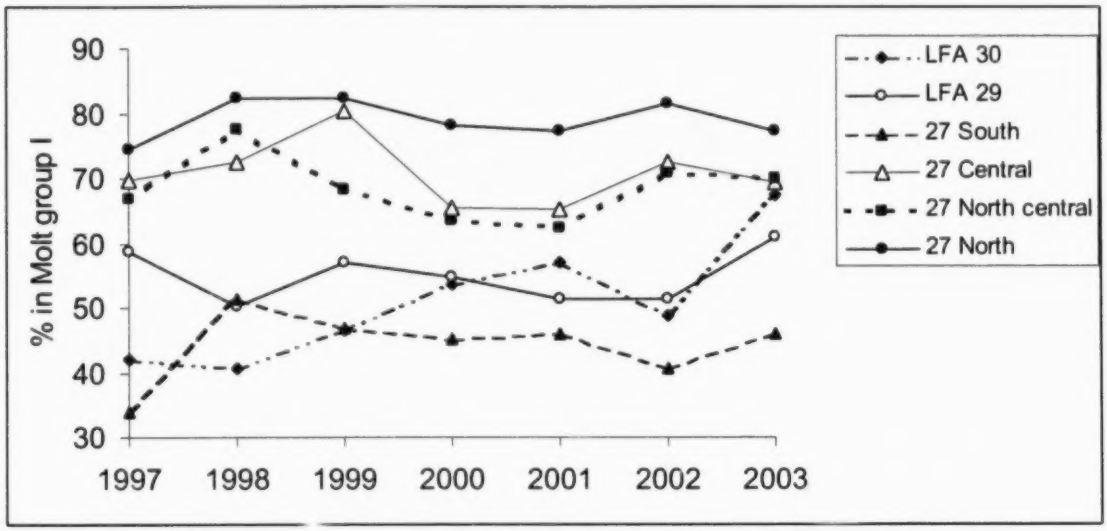


Figure 27. Percentage (by number) of lobsters in molt group I in different LFAs and subareas. Molt group I in year *i* defined as minimum legal size in year *i* plus 14%. Based on weighted length frequencies.

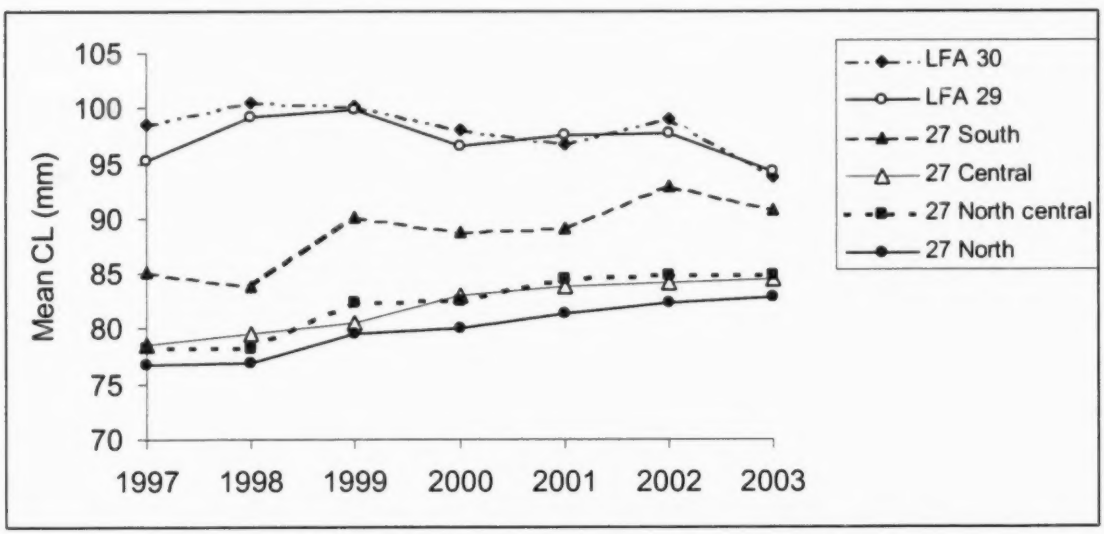


Figure 28. Mean size of lobsters in landed catch in different LFAs and subareas. Based on weighted length frequencies. Note that MLS increased from 70 to 76 mm in LFA 27, from 81 to 84 mm in LFA 29 and 81 to 82.5 mm in LFA 30.

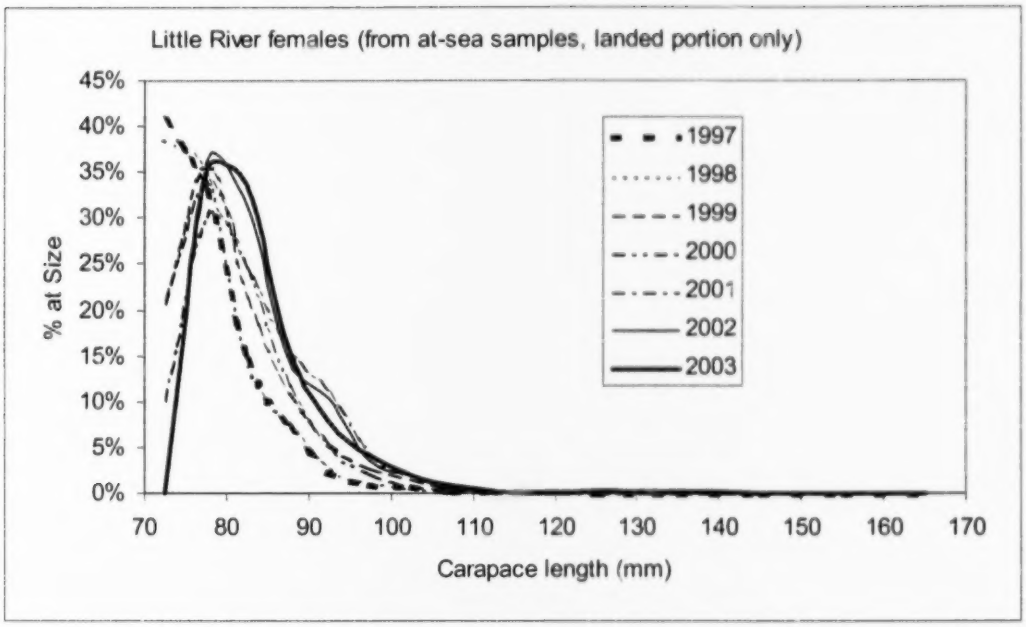
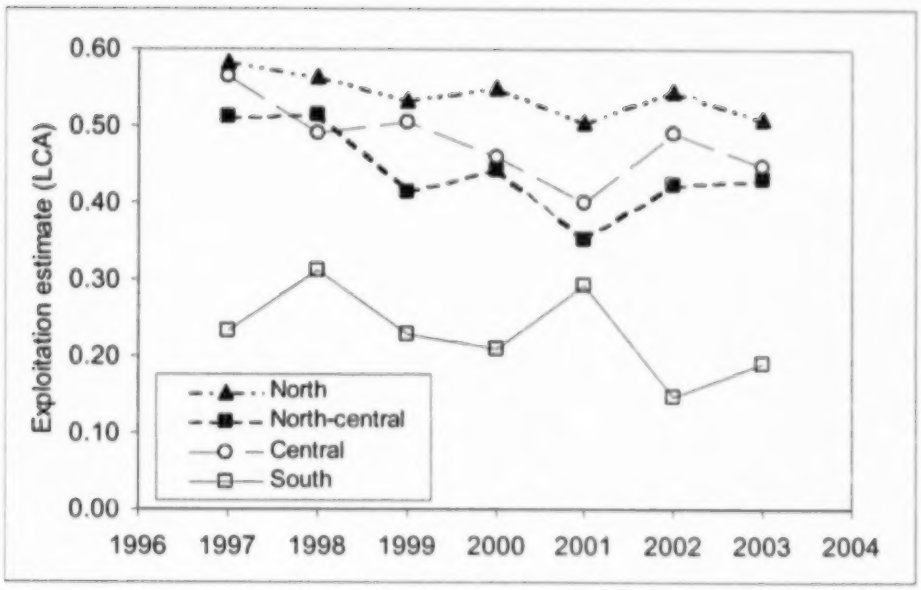


Figure 29. Example of size frequency input to Length-based cohort analysis (LCA). Shown is percent of female lobsters at size from at-sea samples 1997-2003. Samples were weighted based on landings (see Methods).



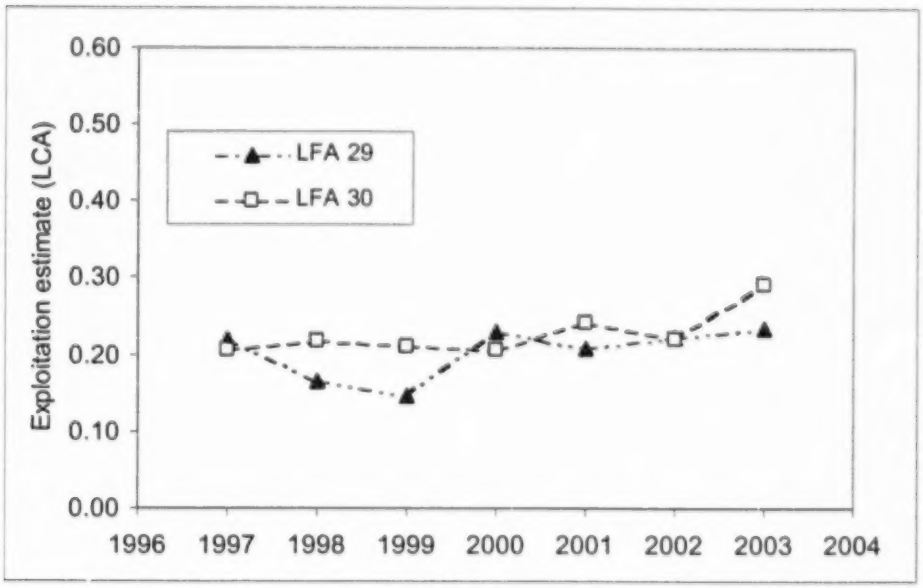


Figure 30. Exploitation estimates for LFAs 27, 29 and 30 from 1997 to 2003. From Length composition analysis (LCA). N = North, NC = North-central, C = Central, S = South.

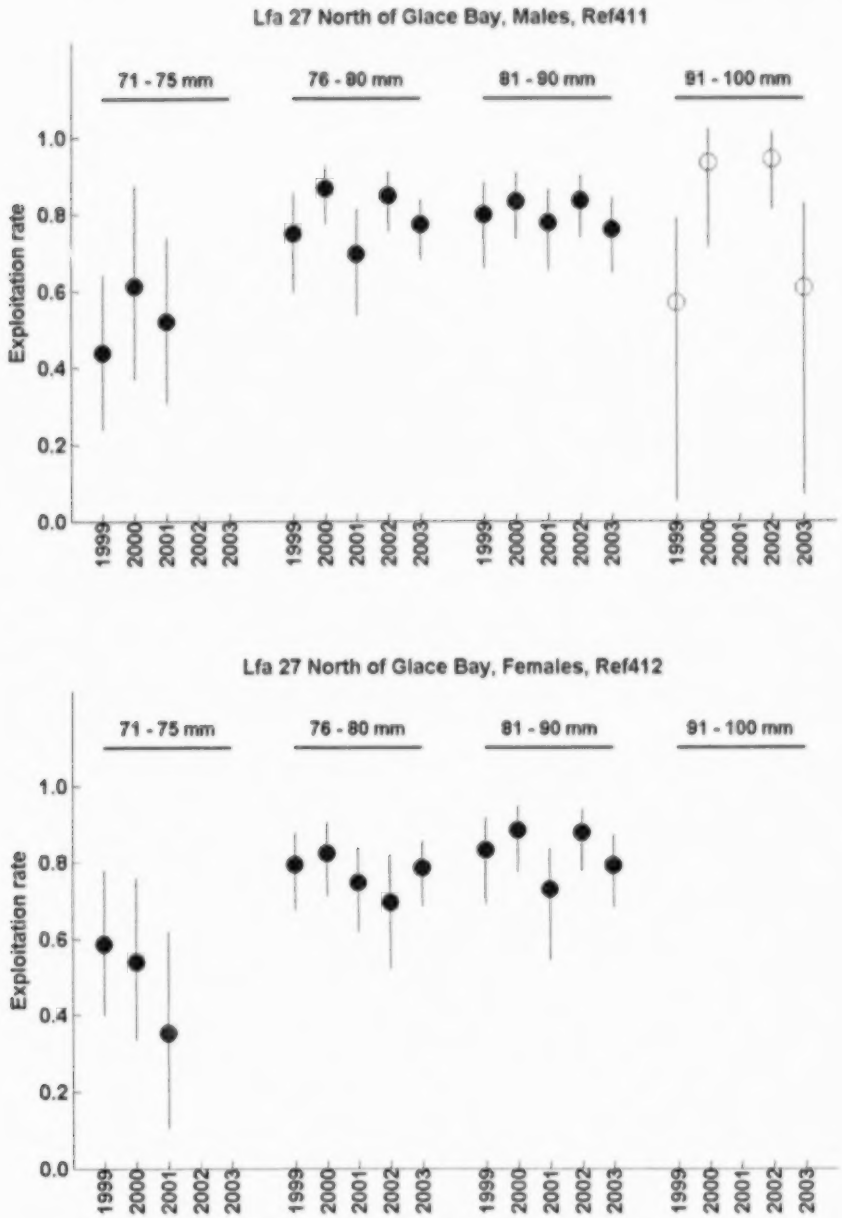


Figure 31. Change-in-ratio estimates of exploitation for LFA 27 North, North-Central and Central combined. Estimates for sizes < 76 mm are extended estimates.

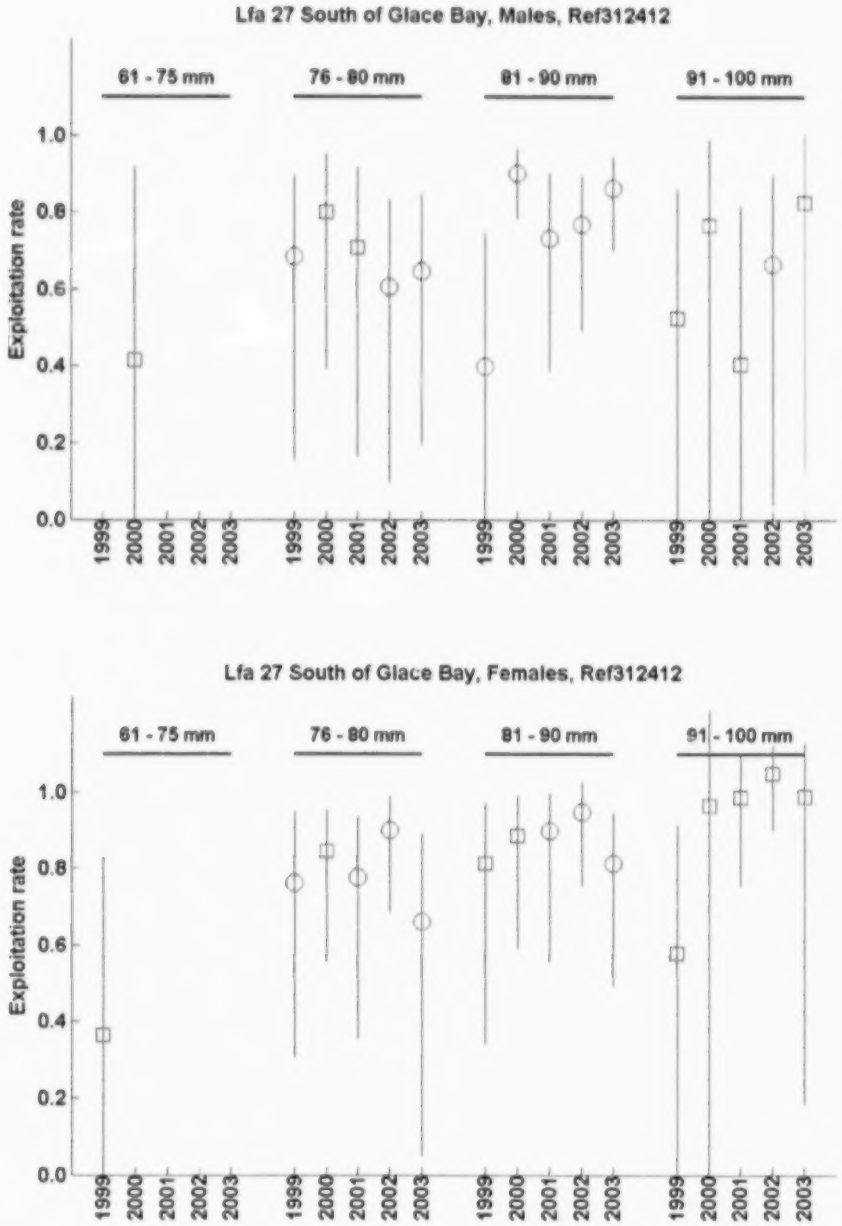


Figure 32. Change-in-ratio estimates of exploitation for LFA 27 South. Estimates for sizes < 76 mm are extended estimates.

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ERRATUM	ERRATUM
Tremblay, J.M., J.A., Reeves. 2004. Eastern Cape Breton Lobster (LFAs 27-30): Stock status and biological effects of the increase in minimum legal size. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/021.	Tremblay, J.M., J.A., Reeves. 2004. Homard de l'est du Cap-Breton (ZPHs 27-30): État du stock et effets biologiques de l'augmentation de la taille légale. Secr. can. de consult. sci. du MPO, Doc. de rech. 2004/021.
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Appendix 1. Report on study of effects of entrance ring size on size of lobsters captured

Introduction

The effect of entrance ring size on the size composition of lobsters in traps was tested by volunteer fishermen in LFA 30 during the spring 2000 and 2001 fishing seasons. Malcolm and Gordon MacDonald (Fourchu) outfitted 80 traps with different ring sizes. Four ring sizes were examined (20 traps each): 5.25", 5.75", 6.85" and 7.35". From May through July 2000, Vivien Bushell (FSRS) was contracted by DFO to sample the at-sea lobster catch. Alan Reeves provided initial training, and John Tremblay provided guidance on study design.

The experimental traps were fished in groups such that each group had equal numbers of the different trap types, and the trap types were set alternately in lines.

It was noted in 2000 that many lobsters were escaping from the trap with the largest ring size. It was thought this was related to the large size of the ring in relation to the trap dimensions. In 2001 a large trap was added to counter this problem. As such there were 100 experimental l traps in 2001. Vivien Bushell was again contracted to do the sampling. In addition to the 20 at-sea samples she completed, Gordon MacDonald completed measurements on another 24 days.

This report deals with the results of the ring-size experiment.

Results

In 2000 a total of 1499 lobsters greater than 60 mm CL were measured from 1592 trap hauls (Table 1). In 2001 a total of 4282 lobsters greater than 60 mm CL were measured from 4191 trap hauls (Table 2). The number of trap hauls per trap type was approximately equal in both years.

In both years the traps with the two smallest ring sizes captured more lobsters overall and more lobsters within the important commercial sizes of 81-120 mm CL. Overall numbers of lobsters > 150 mm CL were low in both years. In 2000 a total of 10 lobsters in this size range were captured in 1592 trap hauls for a catch rate of 1.25 lobsters/200 trap hauls. In 2001 a total of 25 lobsters > 150 mm CL were captured in 4191 trap hauls for a catch rate of 1.19 lobsters/200 trap hauls.

Only these large sizes appeared to be less likely to enter traps with entrance rings less than 6". In 2000 all 10 lobsters were captured in the traps with ring sizes > 6"; in 2001, 20 of the 25 lobsters > 150 mm CL were captured in the traps with rings > 6".

Summary

- Overall catch rate of legal lobsters was highest in the traps with 5.75" and 5.25 "entrance rings, followed by the 6.85" ring traps and the 7.35" ring traps.
- The traps with rings larger than 6" captured more lobsters > 150 mm CL. The numbers of these sizes was low overall (approx 1.2 lobsters /200 trap hauls in both 2000 and 2001)

Acknowledgements

Thanks to Gordon and Malcolm MacDonald for outfitting their traps, conducting the trapping experiment and recording lobster sizes in 2001. Thanks to Vivien Bushell for conducting the at-sea samples in both years.

Table 1. 2000 fishing season. Number of trap hauls by date for each trap type, together with number of lobsters captured.

		Ring Size/Trap Type				Total trap hauls	No. lobsters >60 mm CL
Trip	Date	5.25"	5.75"	6.85"	7.35"		
1	24-May-00	19	19	18	19	75	26
2	30-May-00	20	20	20	20	80	71
3	31-May-00	20	20	20	20	80	83
4	5-Jun-00	20	20	20	20	80	71
5	6-Jun-00	20	20	20	20	80	90
6	10-Jun-00	20	20	20	20	80	68
7	12-Jun-00	20	19	20	20	79	74
8	13-Jun-00	20	20	20	20	80	113
9	14-Jun-00	20	20	20	20	80	72
10	15-Jun-00	20	20	20	20	80	73
11	20-Jun-00	20	20	20	20	80	85
12	21-Jun-00	20	20	20	20	80	70
13	27-Jun-00	20	20	20	20	80	48
14	29-Jun-00	20	20	20	20	80	43
15	4-Jul-00	20	20	20	20	80	41
16	14-Jul-00	20	19	20	19	78	58
17	15-Jul-00	20	20	20	20	80	88
18	17-Jul-00	20	20	20	20	80	134
19	18-Jul-00	20	20	20	20	80	95
20	19-Jul-00	20	20	20	20	80	100
Totals		399	397	398	398	1592	1499

Table 2. 2001 fishing season. Number of trap hauls by date for each trap type, together with number of lobsters captured.

		Ring Size/Trap Type					Total trap hauls	No. lobsters >60 mm CL
Trip No.	Date	5.25"	5.75"	6.85"	7.35"	Large		
1	21-May-01	20	20	20	20	20	100	205
2	22-May-01	20	20	20	20	20	100	121
3	23-May-01	20	20	20	20	20	100	193
4	24-May-01	20	20	20	20	20	100	156
5	25-May-01	20	20	20	20	20	100	166
6	26-May-01	20	20	20	20	20	100	151
7	28-May-01	20	20	20	20	20	100	152
8	29-May-01	20	20	20	20	20	100	112
9	30-May-01	20	20	20	20	20	100	38
10	01-Jun-01	20	20	20	20	20	100	69
11	02-Jun-01	20	20	20	20	20	100	28
12	04-Jun-01	20	20	19	20	19	98	119
13	05-Jun-01	6	6	6	6	6	30	11
14	06-Jun-01	20	20	19	20	20	99	64
15	07-Jun-01	20	20	20	20	20	100	66
16	09-Jun-01	20	20	20	20	20	100	104
17	11-Jun-01	20	20	20	20	20	100	53
18	12-Jun-01	20	20	20	20	20	100	84
19	13-Jun-01	20	20	20	20	20	100	64
20	14-Jun-01	20	20	20	20	20	100	71
21	15-Jun-01	20	20	20	20	20	100	85
22	16-Jun-01	20	20	20	20	20	100	115
23	18-Jun-01	20	20	20	20	20	100	142
24	19-Jun-01	20	19	20	20	19	98	97
25	20-Jun-01	20	20	20	20	20	100	86
26	21-Jun-01	5	5	5	5	5	25	15
27	22-Jun-01	20	20	20	20	20	100	86
28	23-Jun-01	20	20	20	20	20	100	111
29	25-Jun-01	20	20	20	20	20	100	119
30	26-Jun-01	20	20	20	20	20	100	48
31	27-Jun-01	20	20	20	20	19	99	87
32	30-Jun-01	9	9	9	9	9	45	65
33	02-Jul-00	20	20	20	20	20	100	177
34	03-Jul-01	20	20	20	20	20	100	76
35	04-Jul-01	20	20	20	20	20	100	77
36	05-Jul-01	20	20	20	20	20	100	111
37	06-Jul-01	20	20	20	20	20	100	101
38	09-Jul-01	20	20	20	20	20	100	147
39	10-Jul-01	20	20	20	20	20	100	75
40	11-Jul-01	20	19	20	20	20	99	75
41	12-Jul-01	20	19	20	20	20	99	73
42	13-Jul-01	20	20	20	20	20	100	92
43	16-Jul-01	20	20	20	20	20	100	72
44	18-Jul-01	20	19	20	20	20	99	123
	Totals	840	836	838	840	837	4191	4282

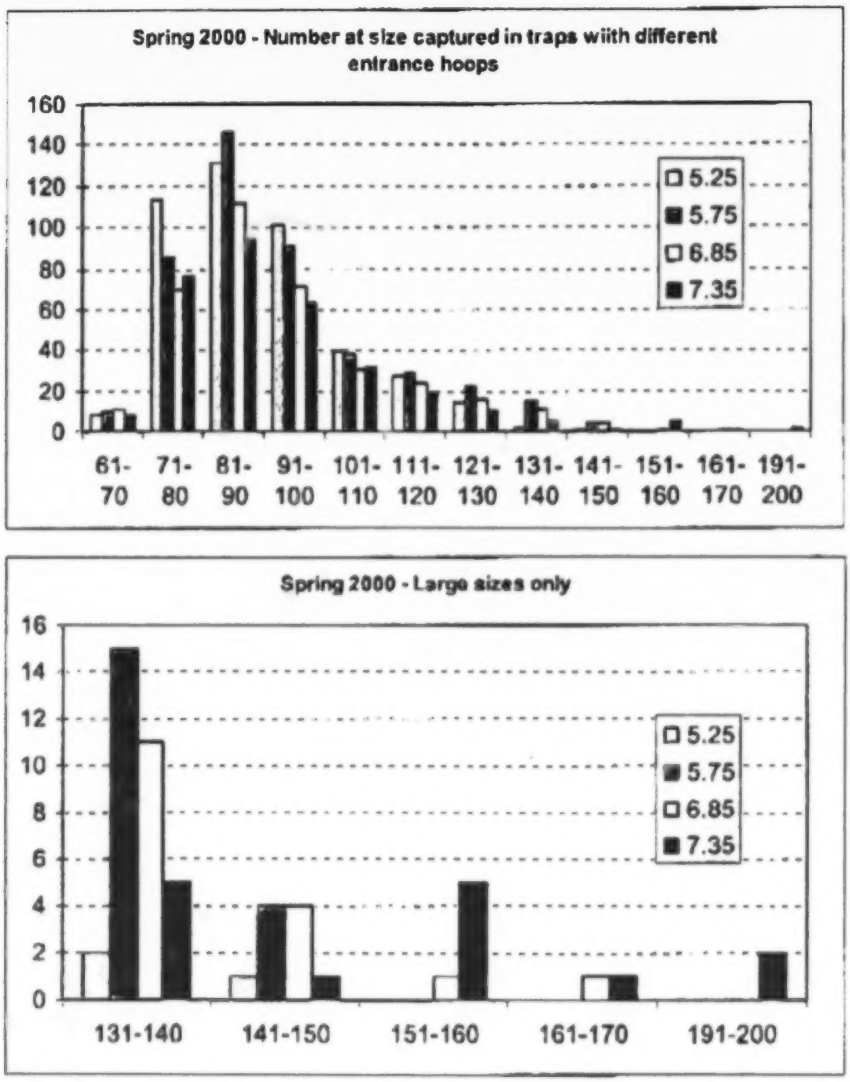

Fig. 1. Total number of lobsters captured in traps with different ring sizes in 2000. Upper figure is all sizes, lower figure is sizes greater than 130 mm CL.

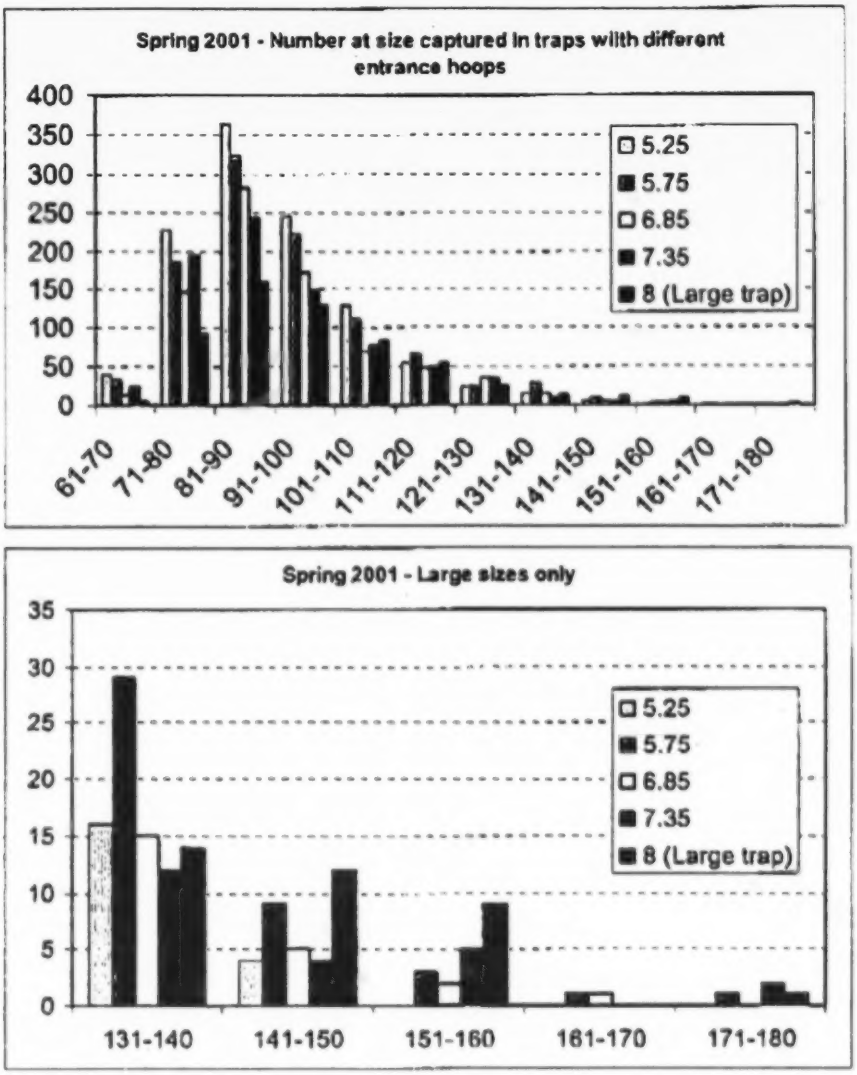

Fig. 2. Total number of lobsters captured in traps with different ring sizes in 2001. Upper figure is all sizes, lower figure is sizes greater than 130 mm CL.